DOCUMENT RESUME

ED 195 791 CE 027 474

AUTHOR Eckes, William; Fulkerson, Dan
TITLE Air Conditioning and Refrigeration Book III.
INSTITUTION Mid-America Vocational Curriculum Consortium, Stillwater, Okla.; Oklahoma State Dept. of Vocational and Technical Education, Stillwater.
PUB DATE Dec 80
NOTE 266p.; Colored pages may not reproduce clearly.

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Air Conditioning; Air Conditioning Equipment; Air Flow; Behavioral Objectives; Building Design; Business Administration; *Climate Control; Course Content; Curriculum Guides; Human Relations; Instructional Materials; *Job Application; Learning Activities; Orientation Materials; Postsecondary Education; *Refrigeration; Secondary Education; *Thermal Environment; Units of Study; Ventilation; *Vocational Education

ABSTRACT

Designed to present theory as a functional aspect, this air conditioning and refrigeration curriculum guide is comprised of nine units of instruction. Unit titles include (1) Job Orientation, (2) Applying for a Job, (3) Customer Relations, (4) Business Management, (5) Psychometrics, (6) Residential Heat Loss and Heat Gain, (7) Duct Design and Sizing, (8) Air Treatment, and (9) Residential Systems. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teachers, information sheets, assignment sheets, visual aids, job sheets, tests, and answers to the tests. It is noted that each unit is planned for more than one lesson or class period of instruction. (LRA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED195791

AIR CONDITIONING AND REFRIGERATION BOOK III

by

WILLIAM ECKES

and

DAN FULKERSON

Developed by the

Mid-America Vocational Curriculum Consortium, Inc.

Board of Directors

David Merrill, South Dakota, Chairman
Merle Rudebusch, Nebraska, Vice Chairman
Peggy Patrick, Arkansas
Darrell Anderson, Colorado
Alyce Williamson, Kansas
David Poston, Louisiana
Amon Herd, Missouri
Alan Morgan, New Mexico
Larry Barnhardt, North Dakota
Bob Patton, Oklahoma
Pat Lindley, Texas
Ann Benson, Executive Director

CE 027 474

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Scott Dean

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

COPYRIGHT - 1981

Mid-America Vocational Curriculum Consortium, Inc.

Printed by

State Department of Vocational and Technical Education
Stillwater, Oklahoma 74074

TABLE OF CONTENTS

Unit I Job Orientation . . . . ACR III - 1

Unit II Applying for a Job . . . . ACR III - 17

Unit III Customer Relations . . . . ACR III - 69

Unit IV Business Management . . . . ACR III - 87

Unit V Psychrometrics . . . . ACR III - 109

Unit VI Residential Heat Loss and Heat Gain . . . . ACR III - 145

Unit VII Duct Design and Sizing . . . . ACR III - 175

Unit VIII Air Treatment . . . . ACR III - 249

Unit IX Residential Systems . . . . ACR III - 273

FOREWORD

As America becomes more energy conscious, the demands on the air conditioning and refrigeration industry will become more complex. Technicians in the industry will have to become proficient in load estimates and equipment sizing. The old theory that "nothing succeeds like excess" is out the window, and the new attitudes ring with the phrase "energy efficient" at every turn.

Technicians who up to this point have learned basic systems and the electronics that make them work will now have to employ the elements of psychometrics to increase their skills and their potential earnings in the job market. They will also be dealing with a public which is more cost conscious, more energy conscious. *Air Conditioning and Refrigeration, Book III* strives to present theory as a functional aspect that can carry the student to a new plateau in skills and earnings in an America that is counting its dollars more carefully and demanding quality service.

The success of this publication is due, in large part, to the capabilities of the personnel who worked with its development. The technical writers have numerous years of industry as well as teaching and writing experience. Assisting them in their efforts were representatives of the air conditioning and refrigeration professions who brought with them technical expertise and the experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, other organizations and industry representatives were involved in the developmental phases of the manual. Appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers in improving instruction. As this publication is used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation. Every effort has been made to make this publication basic, readable, and by all means usable. Three vital parts of instruction have been intentionally omitted: motivation, personalization, and localization. These areas are left to the individual instructors who should capitalize on them. Only then will this publication really become a vital part of the teaching-learning process.

Instructional materials in this publication are written in terms of student performance using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion referenced evaluation instruments are provided for uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

It is the sincere belief of the MAVCC personnel and all those members who served on the committee that this publication will allow the students to become better prepared and more effective members of the work force. If there is anything that we can do to help this publication become more useful to you, please let us know.

David Merrill, Chairman
Board of Directors
Mid-America Vocational Curriculum
Consortium

PREFACE

Air Conditioning and Refrigeration, Book III, is a natural follow-up to the curriculum materials previously published by MAVCC in AC&R I and AC&R II. But this new text is also a response to positive input from teachers who have worked with the first two texts.

Many of these teachers have indicated a desire for a shorter book, one that would be handier to carry and work with. That AC&R III has only nine units is a MAVCC response to an obvious curriculum need, and marks what will probably become the objective of future MAVCC publications.

In a time when educational costs continue to rise, a lower priced text will be welcomed by teachers and students alike. But more than that, curriculum materials presented in such a comprehensive size will be easier to adapt to speciality programs with industry and adult education.

There has never been a MAVCC publication in which we failed to request that teachers and educators let us know how the curriculum is working out in the classroom. [illegible] response to date has helped make the MAVCC format the most solid in vocational-technical education, and this new, comprehensive publication of AC&R III should prove once more that as MAVCC continues to publish we also continue to listen--and respond.

Ann Benson
Executive Director
Mid-America Vocational Curriculum
Consortium

ACKNOWLEDGMENTS

Appreciation is extended to those individuals who contributed their time and talents in the development of *Air Conditioning and Refrigeration, Book III.*

The contents of this publication were planned and reviewed by:

Mid-America Vocational Curriculum Consortium Committee

James A. Nydam	Grand Rapids, Michigan
John L. Healy, Jr.	Colorado Springs, Colorado
Duane Eaton	Washington, D.C.
Keith Frankhauser	Pittsburg, Kansas
Virgil Canning	Seward, Nebraska
Joseph H. Cook	Wahpeton, North Dakota
Ruben H. Roybal	Albuquerque, New Mexico
Russell Johnson	Glendale, Arizona
Dean Andersen	Lebanon, Missouri
Richard Shepperd	Corpus Christi, Texas
John Derraugh	Ottawa, Ontario, Canada
Al Spriggs	Ottawa, Ontario, Canada
Don Dossett	Sioux Falls, South Dakota
Nathan Marshall	Malvern, Arkansas
Ronald Shelton	Colorado Springs, Colorado
Leonard Cokely	Stillwater, Oklahoma
Melvin Solotorovsky	Harlingen, Texas
Jack A. Needham	Wichita, Kansas
Tony Gallego	Albuquerque, New Mexico
David L. Matthews	Bismarck, North Dakota

Special appreciation is extended to Leonard Cokely for his technical assistance with the final draft of the text.

A special thank you is extended to the Air-Conditioning Contractors of America (ACCA) for permission to reprint materials from various manuals published by that organization.

Gratitude is expressed to Jenny Fowler, Teddi Cox, Wendy Rodebaugh, Rose Primeaux, Gari Sha Leisher, Alice Mulder, Robin Ketch, and Terry Stanley of the Graphics Division of Oklahoma State Department of Vocational-Technical Education for typing.

Gratitude is expressed to Bill Dunn, Lin Thurston, Robert Randall, and Nancy Hilley of the Graphics Division of Oklahoma State Department of Vocational-Technical Education for the illustrations used in this publication.

Appreciation is extended to the people at the Oklahoma State Department of Vocational-Technical Education Print Shop for their fine service in printing the text.

A final thank you to Regina Decker and Don Eshelby for their assistance with editing and rewriting.

USE OF THIS PUBLICATION

Instructional Units

Air Conditioning and Refrigeration, Book Three, includes 9 units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teachers, information sheets, assignment sheets, visual aids, job sheets, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name
Label
List in writing
List orally
Letter
Record
Repeat
Give

Identify
Select
Mark
Point out
Pick out
Choose
Locate

Describe
Define
Discuss in writing
Discuss orally
Interpret
Tell how
Tell what
Explain

Order
Arrange
Sequence
List in order
Classify
Divide
Isolate

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Additional Terms Used
Evaluate
Complete
Analyze
Calculate
Estimate
Plan
Observe
Compare
Determine
Perform

Prepare
Make
Read
Tell
Teach
Converse
Lead
State
Write

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor:

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. (NOTE: To overcome the noise of an overhead projector, some teachers have a tendency to speak too loudly, so it is always best to stand away from the projector when discussing transparencies.)

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. In most situations, the instructor should be able to demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)

UNIT I: JOB ORIENTATION

1. Terms
2. Basic skills
3. Business and Communication skills
4. Areas of specialization
5. Best places to look for employment
6. Reasons workers need to be in good physical condition
7. Future employment prospects
8. Other factors affecting future employment
9. Ways to plan for seasonal aspects
10. Other specialized areas
11. Conduct an employment opportunity survey

UNIT II: APPLYING FOR A JOB

1. Terms
2. Means of locating jobs
3. Methods of applying for a job
4. Personal attitudes or attributes employers look for
5. Guidelines for dressing for an interview

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)

Related Information: What the Worker Should Know (Cognitive)

6. Items needed to prepare for applying for a job
7. Guidelines for participating in a job interview
8. Write a resume
9. Write a job application letter
10. Complete an employment application form
11. Practice answering interview questions
12. Make a phone appointment for a job interview
13. Follow-up letter or follow-up phone call after application for a job
14. Evaluate a job offer
15. Compare job opportunities

UNIT III: CUSTOMER RELATIONS

1. Terms
2. Contribution of good personal habits
3. Rules in dealing with customers
4. Basic rules for services calls

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
	5. Service calls as good customer relations opportunities
	6. Ways to handle an irritated customer
	7. Ways vehicle operations affect customer relations
	8. Ways to earn a customer's respect
	9. Respond to problem situations

UNIT IV: BUSINESS MANAGEMENT

	1. Terms
	2. Objectives of good business management
	3. Guidelines for maintaining inventory control
	4. Guidelines for maintaining installation and service records
	5. Ways to gather information for an equipment file
	6. Procedure for handling return goods
	7. Special precautions in handling return goods
	8. Vehicle use, maintenance, and safety
	9. Basic rules for scheduling and service calls
	10. Ways to avoid legal problems
	11. Other management items and how they contribute

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)

Related Information: What the Worker Should Know (Cognitive)

12. How to handle accounting and money with service customers
13. Most important rule of good business management
14. Complete a return goods tag

UNIT V: PSYCHROMETRICS

1. Terms
2. Basic information on a psychrometric chart
3. Dry-bulb temperature readings
4. Wet-bulb temperature readings
5. Dew point temperature readings
6. Relative humidity readings
7. Basic psychrometric processes
8. Air-conditioning processes shown on a psychrometric chart
9. Determine relative humidity
10. Determine dew point
11. Determine how outside air should be conditioned in winter heating
12. Determine how outside air should be conditioned in summer cooling
13. Determine the relative humidity of a conditioned space
14. Determine the relative humidity of an outdoor space
15. Determine the wet-bulb temperature of the air inside a duct

14

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)

UNIT VI: RESIDENTIAL HEAT LOSS AND HEAT GAIN

1. Terms
2. Standard procedures in load calculations
3. Factors in determining heat loss and heat gain
4. Calculating heat transfer multipliers
5. Factors in sizing heating equipment
6. Factors in sizing cooling equipment
7. Ways structural modifications can affect equipment selection
8. Estimate heat loss
9. Calculate shaded and unshaded glass areas
10. Estimate heat gain
11. Evaluate addition of insulation

UNIT VII: DUCT DESIGN AND SIZING

1. Terms
2. Types of supply duct systems
3. Factors affecting system design
4. Major steps of air system design
5. Factors affecting return air duct design
6. Locations of registers and grilles
7. Advantages and disadvantages of register and grille location

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
	8. Climatic zone conditions
	9. Factors in the distribution of conditioned air
	10. Room air patterns, outlet placement, and velocity
	11. The friction loss per 100 ft. chart
	12. The friction chart
	13. Design an air distribution system from a drawing
14. Determine pressure drop across an evaporator coil	
15. Determine CFM delivered by a forced air system	

UNIT VIII: AIR TREATMENT

	1. Terms
	2. Air contaminants
	3. Advantages of proper humidity
	4. Factors which affect humidity
	5. Features of residential filtering equipment
	6. Operation of an electronic filter
	7. Operation of a dehumidifier
	8. Operation of a humidifier
9. Install a humidifier with low voltage controls	
10. Install an electronic filter	

AIR CONDITIONING AND REFRIGERATION BOOK III

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able To Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)

UNIT IX: RESIDENTIAL SYSTEMS

1. Terms
2. Factors in furnace design
3. Major components in furnace construction
4. Furnace control devices
5. Components of a gas burner
6. Components of an oil burner
7. Operation of fan and limit switches
8. Components of a hydronic system furnace
9. Basics of a cooling system
10. Cooling system component functions
11. Evaporative cooling
12. Limitations of evaporative cooling
13. Heat pump design and operation

TOOLS, MATERIALS, AND EQUIPMENT LIST

Tools

Sling psychrometer
Awl
Left hand aviation snips
Screwdriver
1/4" nut driver

Materials

Duct tape
Distilled water
Psychrometric chart
Clean cotton wick
1/4" OD copper tubing as needed
Thermostat cable (2-wire #18) as needed
SPST relay (24v coil)
#14 insulated stranded wire as needed
1/4" sheet metal screws as needed
Twenty-four 1/2" sheet metal screws

Equipment

Duct as selected by instructor
Conditioned space as selected by instructor
Forced air heating system as selected by instructor
Humidifier and accessories
Electronic filter and accessories

REFERENCES

(NOTE: This is an alphabetized list of references used in completing this text.)

Allen, Cliff. "About Getting a Job" and "After High School--What:" *Practical Family Life*. Greenfield, Mass.: Channing L. Bete, Inc., 1977.

Althouse, Andrew D., and Carl H. Turnquist and Alfred F. Bracciano. *Modern Refrigeration and Air Conditioning*. South Holland, IL 60473: The Goodheart-Willcox Company, Inc., 1975.

Blackledge, Ethel H.; Blackledge, Walter, L.; and Helen J. Keily. *You and Your Job*. Dallas: South-Western Publishing Company, 1967.

Can I Get the Job? Detroit: General Motors Public Relations Staff, 1972.

Carrier Air Conditioning Company. *Handbook of Air Conditioning System Design*. New York, NY: McGraw-Hill, Inc., 1965.

Feingold, S. Norman, and Swerdloff, Sol. *Occupations and Careers*. St. Louis: McGraw-Hill Book Company/Webster Division, 1969.

Fruehling, Rosemary T. *Working at Human Relations*. New York: Gregg Division/McGraw-Hill Book Company, 1977.

Handbook of Job Facts. Chicago, IL: Science Research Associates, Inc., 1972.

Interviewing Women Candidates. Washington, D.C.: U.S. Civil Service Commission, 1974.

Keeton, Marsha. *Job Application and Interview*. University of Kentucky: Vocational Education Curriculum Development Center of Kentucky, 19[illegible]

Kimbrell, Grady, and Vineyard, Ben S. *Succeeding in the World of Work*. Bloomington, Illinois: McKnight Publishing Company, 1975.

Lang, Paul V. *Principles of Air Conditioning*. Albany, NY 12205: Delmar Publishers/Litton Educational Publishing, Inc., 1972.

Manual A, What is Comfort Air Conditioning? Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1961.

Manual B, Principles of Air Conditioning. Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1970.

Manual C, What Makes a Good Air Conditioning System. Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1966.

Manual E, Room Air Distribution Considerations. Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1965.

Manual 4, Installation Techniques for Perimeter Heating and Cooling. Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Ninth Edition, 1964.

Manual G, Selection of Distribution System. Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1965.

Manual J, Load Calculation for Residential Winter and Summer Air Conditioning. Washington, DC 20036: The Air-conditioning Contractors of America (ACCA), Fifth Edition, First Printing, 1980.

Manual K, Equipment Selection and System Design Procedures. Washington, DC 20036: The Air-Conditioning Contractors of America (ACCA), Second Edition, 1975.

Milburn, Paul M. *How to Get a Job*. Shawnee, Oklahoma: Gordon Cooper Area Vocational Technical School, 1967.

Moynihan, Moyhihan, and Daeger. *You and Your Job--How to Get It*. Chicago: J.G. Ferguson Publishing Company, 1968.

1980 U.S. Industrial Outlook for 200 Industries with Projections for 1984. Washington, D.C. 20402: U.S. Department of Commerce, Industry and Trade Administration, 1980.

Occupational Outlook Handbook, 1980-81 Edition. Washington, D.C. 20402: U.S. Department of Labor, Bureau of Labor Statistics, 1980.

"Preliminary Notes on Manual D." Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Unpublished new manual in committee.

Russell, Allen. *Getting Started in Heating and Air Conditioning Service*. Birmingham, MI: Business News Publishing Company, 1973.

Taylor, Mark. *Residential Wiring*. Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1978.

"The Total Comfort System Story." Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Customer education pamphlet.

Understanding the Friction Chart. Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), 1967.

Weaver, Michael and Kirkpatrick, James. *Environment Control*. New York: Harper and Row, 1974.

Wood, Merle W., and McKeena, Margaret. *The Receptionist*. Dallas: McGraw-Hill Book Company/Gregg Division, 1966.

Your Attitude is Showing. Austin, Texas: Instructional Materials, Divsion of Extension/ University of Texas, 1972.

JOB ORIENTATION
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the basic skills and abilities that promote success as a heating, air conditioning and refrigeration worker, and discuss the areas of specialization and job opportunities in the industry. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to job orientation with their correct definitions.
2. Select basic skills required for success in the industry.
3. Select true statements concerning business and communications skills that promote success in the industry.
4. Match areas of specialization in the industry with statements of what they include.
5. List the best places to look for employment.
6. List reasons why workers in the industry need to be in good physical condition.
7. Select true statements concerning future employment prospects in the industry.
8. List other factors affecting prospects for future employment.
9. Select ways to plan for seasonal aspects of the industry.
10. Select true statements concerning other specialized areas that offer job opportunities.
11. Conduct an employment opportunity survey

JOB ORIENTATION
UNIT I

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information sheet.

III. Discuss unit and specific objectives.

IV. Discuss information sheet.

V. Invite a local heating, air conditioning and refrigeration contractor to talk to the class concerning job opportunities and the special demands of the industry.

VI. Discuss the advantages and disadvantages of specializing in residential or commercial work.

VII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Assignment Sheet #1--Conduct an Employment Opportunity Survey

  D. Test

  E. Answers to test

II. References:

  A. *1980 U.S. Industrial Outlook for 200 Industries with Projections for 1984.* Washington, D.C. 20402: U.S. Department of Commerce, Industry and Trade Administration, 1980.

  B. *Handbook of Job Facts.* Chicago, IL: Science Research Associates, Inc., 1972.

  C. *Occupational Outlook Handbook, 1980-81 Edition.* Washington, D.C. 20402: U.S. Department of Labor, Bureau of Labor Statistics, 1980.

JOB ORIENTATION
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Engineers--People who have completed formal college or university programs in air conditioning and refrigeration; they must frequently pass federal or state exams for certification, and they design, develop, install, and test air conditioning and refrigeration equipment

   B. Technicians--People who have completed advanced technical studies in air conditioning and refrigeration; they assist engineers in research and development, install and test equipment, and supervise mechanics on the job

   C. Mechanics--People who have completed basic studies in air conditioning and refrigeration and who have advanced their skills through several years of apprenticeship training in on-the-job installation, repair, and maintenance

II. Basic skills required for success in the industry

   A. Aptitude for science and math

   B. Mechanical ability

   C. Knowledge of electricity and its practical applications

   D. Familiarity with the related trades of carpentry, plumbing, sheet metal work, and welding

   E. Problem-solving ability

III. Business and communication skills that promote success in the industry

   A. An ability to communicate with customers and establish good customer relations

   B. An ability to schedule and use time constructively

   C. An ability to handle paper work and keep accurate records of inventories, materials used on jobs, etc.

   D. An ability to see situations where your personal efforts can bring more business to your employer

   E. An ability to read and understand the technical magazines and other publications that record the advancements in a rapidly changing industry

INFORMATION SHEET

IV. Areas of specialization and what they include

A. Residential--Includes home cooling systems, window air conditioners, freezers, and refrigerators

B. Commercial--Includes small automatic systems like those found in stores and supermarkets, water coolers, beverage coolers, and truck refrigeration systems

C. Industrial--Includes the large air conditioning systems like those found in processing and packing plants, cold storage systems, ice rinks, and enclosed sports arenas

V. Best places to look for employment

A. Cooling and heating contractors employ most heating and air conditioning and refrigeration workers at all skills levels

B. Fuel oil dealers employ many oil burner mechanics

C. Organizations that operate large air conditioning, refrigeration, and heating systems usually employ their own engineers, technicians, and mechanics

D. Manufacturers

E. Schools

F. Self employment

(NOTE: Most statistics indicate that more than 10 percent of all skilled air conditioning and refrigeration mechanics are self employed.)

VI. Reasons why workers in the industry need to be in good physical condition

A. Although the work is frequently inside, in hot weather the air conditioning is usually off, and in cold weather the heat is usually off

B. Many jobs are performed in cramped quarters

C. Some jobs require climbing or working in high places

D. Many jobs present potential hazards from electrical shock, torch burns, and muscle strain and other injuries from handling heavy equipment

E. Some jobs require considerable driving and the transport of machinery or parts to and from a repair shop

INFORMATION SHEET

VII. Future employment prospects in the industry

A. Employment for skilled mechanics in the trade is expected to increase about as fast as the average for all occupations through the 1980's

B. Hourly rates for skilled mechanics in the trade should remain higher than hourly rates for production and nonsupervisory workers in private industry

(NOTE: Statistics indicate that skilled air conditioning, refrigeration, and heating mechanics earn an average hourly wage 20 to sometimes 50 percent higher than production and nonsupervisory workers.)

C. The movement of skilled workers to allied industries, and the retirement of other skilled workers will create continued job opportunities in the industry

D. Employers frequently prefer to hire students who have completed vocational training in air conditioning and refrigeration because they require less on-the-job training

E. People who work on both air conditioning and heating equipment frequently earn more money than those who work on only one kind of equipment

VIII. Other factors affecting prospects for future employment

A. The ups and downs in the national economy, especially in new housing starts, will affect total employment in the industry

(NOTE: Even this traditional employment guideline has its ups and downs; the unusually hot summer of 1980 triggered increased demand for air conditioning installation and service in a large part of the country at a time when new housing starts were at a near record low.)

B. Federal and state emphasis on energy conservation will create new jobs in solar applications in both heating and cooling

C. Changing technology designed to meet changing federal and state requirements for energy efficient equipment will create demands for new skills

(NOTE: Service specialists will have to update their skills to handle new products.)

IX. Ways to plan for seasonal aspects of the industry

A. Select a shop that has a year round operation

(NOTE: Year round operations usually mean that workers put in long days and earn considerable overtime pay during the peak heating or cooling seasons.)

INFORMATION SHEET

B. Develop skills in both heating and air conditioning installation and repair

C. Develop skills in an allied industry, especially sheet metal work, residential wiring, plumbing or pipefitting, or refrigerator or freezer repair

X. Other specialized areas that offer job opportunities

A. Companies that specialize in heating and cooling load calculations and system designs

B. Companies that specialize in control systems, their installation, and maintenance

C. Utilities whose representatives call on home builders or assist in public relations efforts by planning conservation clinics

D. Companies that specialize in service contracts

E. Manufacturers who hire representatives to call on dealers, architects, and engineers involved in project design and construction

JOB ORIENTATION
UNIT I

ASSIGNMENT SHEET #1--CONDUCT AN EMPLOYMENT OPPORTUNITY SURVEY

Directions: Using available sources such as a local or area newspaper, yellow pages of the telephone book, trade journal, or your personal knowledge of local or area contractors, determine the employment opportunities for air conditioning and refrigeration mechanics in your area or community. Whether you plan to write or call a company for information, identify yourself, say why you are conducting the survey, and request to speak (or address your letter) to the owner or a supervisor who is qualified to answer your questions.

EMPLOYMENT OPPORTUNITY SURVEY by____________________Date(s)________

Name, address, and phone number of company or employer	Number of employees and their job responsibilities	Average openings per year	Areas of Specialization
1.			
2.			
3.			

(NOTE: For additional entries, make a continuation of this chart on the back of this page.)

JOB ORIENTATION
UNIT I

NAME ______________________________

TEST

1. Match the terms on the right with their correct definitions.

_____ a. People who have completed formal college or university programs in air conditioning and refrigeration; they must frequently pass federal or state exams for certification, and they design, develop, install, and test air conditioning and refrigeration equipment

_____ b. People who have completed advanced technical studies in air conditioning and refrigeration; they assist engineers in research and development, install and test equipment, and supervise mechanics on the job

_____ c. People who have completed basic studies in air conditioning and refrigeration and who have advanced their skills through several years of apprenticeship training in on-the-job installation, repair, and maintenance

1. Mechanics
2. Engineers
3. Technicians

2. Select basic skills required for success in the industry by placing an "X" in the appropriate blanks.

_____ a. Aptitude for science and math

_____ b. Mechanical ability

_____ c. Knowledge of highly technical electronic components

_____ d. Familiarity with the related trades of carpentry, plumbing, sheet metal work, and welding

_____ e. Ability to solve crossword puzzles

3. Select true statements concerning business and communications skills that promote success in the industry by placing an "X" in the appropriate blanks.

_____ a. An ability to communicate with customers only when forced into it

_____ b. An ability to use time so you can take a break whenever you feel like it _____c. An ability to handle paper work and keep accurate records of inventories, materials used on jobs, etc.

_____d. An ability to see situations where your personal efforts can bring more business to your employer

_____e. An ability to read and understand the technical magazines and other publications that record the advancements in a rapidly changing industry

4. Match the areas of specialization on the right with statements of what they include.

_____a. Includes home cooling systems, window air conditioners, freezers, and refrigerators

_____b. Includes small automatic systems like those found in stores and supermarkets, water coolers, beverage coolers, and truck refrigeration systems

_____c. Includes the large air conditioning systems like those found in processing and packing plants, cold storage systems, ice rinks, and enclosed sports arenas

1. Commercial
2. Residential
3. Industrial

5. List five best places to look for employment.

a.

b.

c.

d.

e.

6. List four reasons why workers in the industry need to be in good physical condition.

a.

b.

c.

d.

7. Select true statements concerning future employment prospects in the industry by placing an "X" in the appropriate blanks.

   _____a. Employment for skilled mechanics in the trade is expected to decrease in the 1980's

   _____b. Hourly rates for skilled mechanics in the trade should remain higher than hourly rates for production and nonsupervisory workers in private industry

   _____c. The movement of skilled workers to allied industries, and the retirement of other skilled workers will create continued job opportunities in the industry

   _____d. Employers frequently prefer to hire students who have completed vocational training in air conditioning and refrigeration because they require less on-the-job training

   _____e. People who work on both air conditioning and heating equipment frequently earn less money than those who work on only one kind of equipment

8. List two other factors affecting prospects for future employment.

   a.

   b.

9. Select ways to plan for seasonal aspects of the industry by placing an "X" in the appropriate blanks.

   _____a. Select a shop that you know does a good business during the peak heating or cooling season, and don't worry about the off season

   _____b. Specialize in only air conditioning and forget about wasting time learning anything about heating

   _____c. Develop skills in an allied industry, especially sheet metal work, residential wiring, plumbing or pipefitting, or refrigerator or freezer repair

10. Select true statements concerning other specialized areas that offer job opportunities by placing an "X" in the appropriate blanks.

    _____a. Companies that specialize in heating and cooling load calculations and system designs

    _____b. Companies that specialize in control systems, their installations, and maintenance

    _____c. Utilities whose representatives call on home builders or assist in public relations efforts by planning conservation clinics

    _____d. Companies that specialize in only new home installations

    _____e. Manufacturers who hire representatives to call on dealers, architects, and engineers involved in project design and construction

11. Conduct an employment opportunity survey

(NOTE: If item 11 has not been completed prior to the test, ask your instructor when it should be completed.)

JOB ORIENTATION
UNIT I

ANSWERS TO TEST

1. a. 2
   b. 3
   c. 1

2. a, b, d

3. c, d, e

4. a. 2
   b. 1
   c. 3

5. Any five of the following:

   a. Cooling and heating contractors employ most heating and air conditioning and refrigeration workers at all skills levels

   b. Fuel oil dealers employ many oil burner mechanics

   c. Organizations that operate large air conditioning, refrigeration, and heating systems usually employ their own engineers, technicians, and mechanics

   d. Manufacturers

   e. Schools

   f. Self employment

6. Any four of the following:

   a. Although the work is frequently inside, in hot weather the air conditioning is usually off, and in cold weather the heat is usually off

   b. Many jobs are performed in cramped quarters

   c. Some jobs require climbing or working in high places

   d. Many jobs present potential hazards from electrical shock, torch burns, and muscle strain and other injuries from handling heavy equipment

   e. Some jobs require considerable driving and the transport of machinery or parts to and from a repair shop

7. b, c, d

8. Any two of the following:

   a. The ups and downs in the national economy, especially in new housing starts, will affect total employment in the industry

   b. Federal and state emphasis on energy conservation will create new jobs in solar applications in both heating and cooling

   c. Changing technology designed to meet changing federal and state requirements for energy efficient equipment will create demands for new skills

9. c

10. a, b, c, e

11. Evaluated to the satisfaction of the instructor

APPLYING FOR A JOB
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to locate a job opening, make a formal application, and effectively interview for a job. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to applying for a job with their correct definitions.
2. List means of locating job openings.
3. List three methods of applying for a job.
4. Select personal attributes or attitudes an employer looks for during a personal interview.
5. Select guidelines for dressing for an interview.
6. List four items which an applicant may need to prepare when applying for a job.
7. Select guidelines to follow when participating in a job interview.
8. Write a resume.
9. Write a letter of application for a job.
10. Complete an employment application form.
11. Practice answering interview questions.
12. Make an appointment by phone for a job interview.
13. Write a follow-up letter or make a follow-up phone call after interviewing for a job.
14. Evaluate a job offer.
15. Compare job opportunities.

APPLYING FOR A JOB
UNIT II

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Invite a personnel officer to discuss "What I look for on application letters, resumes, employment application forms, and follow-up devices" and "How do equal opportunity and affirmative action affect my hiring procedures?"

VII. Obtain actual letters of application and resumes to show to students.

VIII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--Attitudes
  - 2. TM 2--Appropriate Dress
  - 3. TM 3--Take Time to be on Time
- D. Assignment sheets
  - 1. Assignment Sheet #1--Write a Resume
  - 2. Assignment Sheet #2--Write a Letter of Application for a Job
  - 3. Assignment Sheet #3--Complete an Employment Application Form
  - 4. Assignment Sheet #4--Practice Answering Interview Questions
  - 5. Assignment Sheet #5--Make an Appointment by Phone for a Job Interview

6. Assignment Sheet #6--Write a Follow-up Letter or Make a Follow-up Phone Call after Interviewing for a Job

7. Assignment Sheet #7--Evaluate a Job Offer

8. Assignment Sheet #8--Compare Job Opportunities

F. Test

G. Answers to test

III. Unit references:

A. Blackledge, Ethel H.; Blackledge, Walter L.; and Helen J. Keily. *You and Your Job.* Dallas: South-Western Publishing Company, 1967.

B. Milburn, Paul M. *How to Get a Job.* Shawnee, Oklahoma: Gordon Cooper Area Vocational Technical School, 1967.

C. Moynihan, Moynihan, and Daeger. *You and Your Job--How to Get It* . Chicago: J. G. Ferguson Publishing Company, 1968.

D. Wood, Merle W., and McKeena, Margaret. *The Receptionist.* Dallas: McGraw-Hill Book Company/Gregg Division, 1966.

E. *Can I Get the Job?* Detroit: General Motors Public Relations Staff, 1972.

F. Keeton, Marsha. *Job Application and Interview.* University of Kentucky: Vocational Education Curriculum Development Center of Kentucky, 1973.

G. *Interviewing Women Candidates.* Washington, D. C.: U. S. Civil Service Commission, 1974.

H. *Your Attitude Is Showing.* Austin, Texas: Instructional Materials, Division of Extension/University of Texas, 1972.

I. Allen, Cliff. "About Getting a Job" and "After High School--What?" *Practical Family Life.* Greenfield, Mass.: Channing L. Bete, Inc., 1977.

J. Kimbrell, Grady, and Vineyard, Ben S. *Succeeding in the World of Work.* Bloomington, Illinois: McKnight Publishing Company, 1975.

K. Feingold, S. Norman, and Swerdloff, Sol. *Occupations and Careers.* St. Louis: McGraw-Hill Book Company/Webster Division, 1969.

APPLYING FOR A JOB
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Award--Recognition received for outstanding achievement

B. Extracurricular activities--Clubs, organizations, and social or church groups in which one participates

C. Fringe benefits--Extras provided by an employer, such as paid vacations, sick leave, and insurance protection

D. Qualifications--Experience, education, and physical characteristics which suit a person to a job

E. Resume--Brief, typed summary of one's qualifications and experience that is used in applying for a job

F. Vocational preparation--Any vocational courses and skills one has learned in high school or through work experience

G. Interview--Meeting of employer and job applicant for purpose of evaluation and questioning

H. Application form--Printed form on which job applicants record information about their personal history, job history, job experience, education, and references

I. Blind ad--Classified advertising that does not identify the advertiser

(NOTE: Applicant is asked to send a letter of application and resume to a post office box number or to call a certain number.)

J. Help wanted ad--Classified advertisement telling what kind of job is available and what the qualifications are

K. Employment/situation wanted ad--Classified advertisement placed by individuals seeking employment and telling what their qualifications are

L. Employment agency--Business that is designed to help individuals find employment

M. Garnishee--To attach wages or other property to satisfy a debt

N. Legible--Capable of being read; clear

O. Equal opportunity employer--Employer who is making a special effort to assure that no form of discrimination is practiced

Examples: Age, sex, race, creed

INFORMATION SHEET

II. Means of locating job openings

- A. Classified ads
    - 1. Newspapers
    - 2. Magazines
- B. Employment offices
    - 1. Department of Labor
    - 2. Private

      (NOTE: A fee is charged by most private agencies.)
- C. Local labor union business office
- D. School officials
    - 1. Teacher
    - 2. Counselor
    - 3. Principal

III. Methods of applying for a job

- A. Letter
- B. Telephone
- C. In person

IV. Personal attributes or attitudes an employer looks for during a personal interview (Transparency 1)

- A. Enthusiasm and interest
- B. Dedication and dependability
- C. Alertness, quickness of mind
- D. Honesty and integrity
- E. Desire to work
- F. Desire to help others
- G. Desire to improve one's self

INFORMATION SHEET

V. Guidelines for dressing for an interview (Transparency 2)

  A. Job-related guidelines

    1. Kind of job

    (NOTE: A "rule of thumb" for any job interview is to dress better for the interview than you would for a day on the job.)

    2. Salary range

  B. Personal guidelines

    1. Coordinate clothing

    2. Be conservative

    3. Be modest and well-groomed

VI. Items which applicant may need to prepare when applying for a job (Assignment Sheets #1, #2, #3, and #6)

  A. Resume

  B. Letter of application

  C. Application form

  D. Follow-up letter

VII. Guidelines to follow when participating in a job interview (Transparency 3)

  A. Preparing for the interview

    1. Be clean

    2. Be well-groomed and neat

    3. Wear appropriate clothes and shoes for the type of job

    4. Take an ink pen and resume with the information you may need about social security number, references, names and addresses, dates employed, and dates attended school

    5. Go alone; do not take parents or friends

    6. Do not be late; allow enough time

INFORMATION SHEET

7. Find out facts about the interviewer ahead of time
    a. Name

       (NOTE: Make sure you have the correct pronunciation.)

    b. Title

8. Know facts about the business
    a. Name
    b. Kind of business
    c. Products and services
    d. Reasons you want to work there
    e. How old the company is and where the plants, offices, or stores are located

B. Meeting the receptionist/secretary

1. Smile
2. Introduce yourself, stating that you have an appointment

   Example: "Good morning. I am Terry McKracken and am applying for a job as an air conditioning serviceman. I have a ten o'clock appointment with Mr. Smith."

3. Follow receptionist's/secretary's instructions
4. Wait patiently

C. Starting the interview

1. Smile
2. Listen
3. Enter with poise
4. Greet the interviewer by name
5. Shake hands firmly
6. Introduce yourself

INFORMATION SHEET

7. State purpose of call
8. Be seated only at interviewer's invitation
9. Do not show signs of nervousness
10. Do not place personal things on interviewer's desk
11. Do not smoke or chew gum
12. Look alert; look interested and enthusiastic

    (NOTE: Sit slightly forward in chair to give an alert appearance.)

13. Be confident
14. Be courteous

    (NOTE: Words such as *Mr., Mrs., Miss, Ms., thank you, please,* and *Sir* never go out of style.)

D. Answering questions clearly

1. Do not interrupt
2. Anticipate questions that might be asked and volunteer proper information
    a. Explain yes and no answers
    b. Avoid criticisms of former employers or competitors
    c. Do not talk about personal problems
    d. Show copies of your work if applicable
    e. Answer all questions honestly

Examples: "The thing I liked least about my last job was that I was on the night shift and couldn't get changed. I really wanted to be home with my family at night."

"Truthfully, my relationship with my supervisor could have been better. We seemed to have a personality conflict and never became fond of each other. However, we did manage to work together. This was my first experience like that and I surely hope it doesn't happen again."

INFORMATION SHEET

f. Give positive answers to unfavorable questions

Examples: Interviewer: "Your work experience doesn't seem to relate specifically to this job. Why do you feel qualified to fill this position?"

Applicant: "I understand your concern. However, my job experience is broad enough to permit me to work into this particular situation. I have done work similar to this job and I think my general work record is good enough to convince you that I would be a good employee. I would be willing to receive additional training."

g. Find a true, positive statement about your reasons for leaving previous jobs, even if you were fired

Examples: "I was laid off, but I learned from my mistakes."

"I left because they did not need as many employees during the slow season."

h. Try to mention your best qualities in relation to something concrete

Example: "I earned 75 percent of my expenses while going to school" is better than "I am a hard worker and want to get ahead."

i. Be prepared for personal questions about your home life and parents' occupations

j. Avoid questions concerning politics, economics, religion, and other controversial subjects

k. Answer questions about career objectives using specific terms about what you would like to do in the near future in that particular field without limiting your opportunities

3. Look directly at interviewer

4. Speak in clear, moderate tones

5. Use correct English

(NOTE: Avoid swearing, slang terms, or annoying phrases like "yeah," or "your know," or "uh-huh.")

INFORMATION SHEET

6. Show interest in the business; ask questions

   Example: Incorrect: "Listen, I need to know if you have any benefits."

   Incorrect: "Now that you've questioned me, there are a few things that I want to know before I decide if I want to work for you."

   Correct: "I wonder if you could give me some information about the benefits available to employees?"

7. Sell yourself

   (NOTE: Never refer to yourself as just average or fair. Always look for a positive response.)

8. Do not get flustered

9. Give the interviewer the opportunity to mention salary and fringe benefits

10. Act enthusiastically

E. Closing the interview

1. Watch for signs that the interview is over, such as the interviewer shuffling papers and moving around in chair

2. Ask "May I say one thing more?" or "Would you be interested in . . .?" if the interview seems to be ending before all important selling points have been made

3. Thank interviewer for his/her time

   Example: "I've enjoyed talking to you, Mr. Smith. Thank you for your time and consideration. I'm excited about this job and do hope I'm hired. Can you tell me when the position will be filled and how the applicants will be notified? (Answer) Please let me know if you need any additional information."

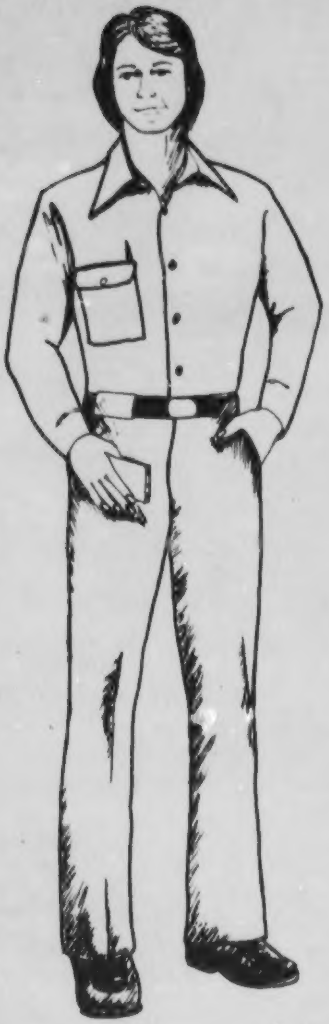
4. Learn from every situation even if the interviewer does not offer the position

F. Following up the interview--Write thank you letter, call, or visit again to express interest in the job and appreciation for the opportunity to interview

Attitudes

Enthusiasm, Interest, Dedication, Dependability, Alertness, Quickness of mind, Honesty, Integrity, Desire to work, Desire to help others, Desire to improve one's self

Appropriate Dress



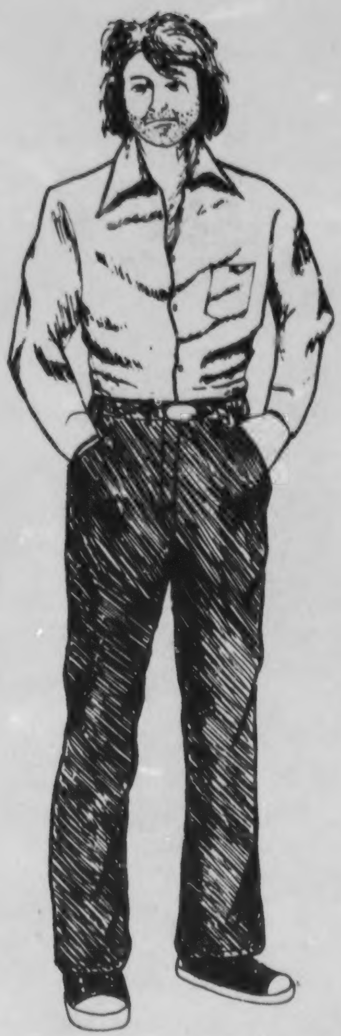
Hair neat?

Shoes shined?

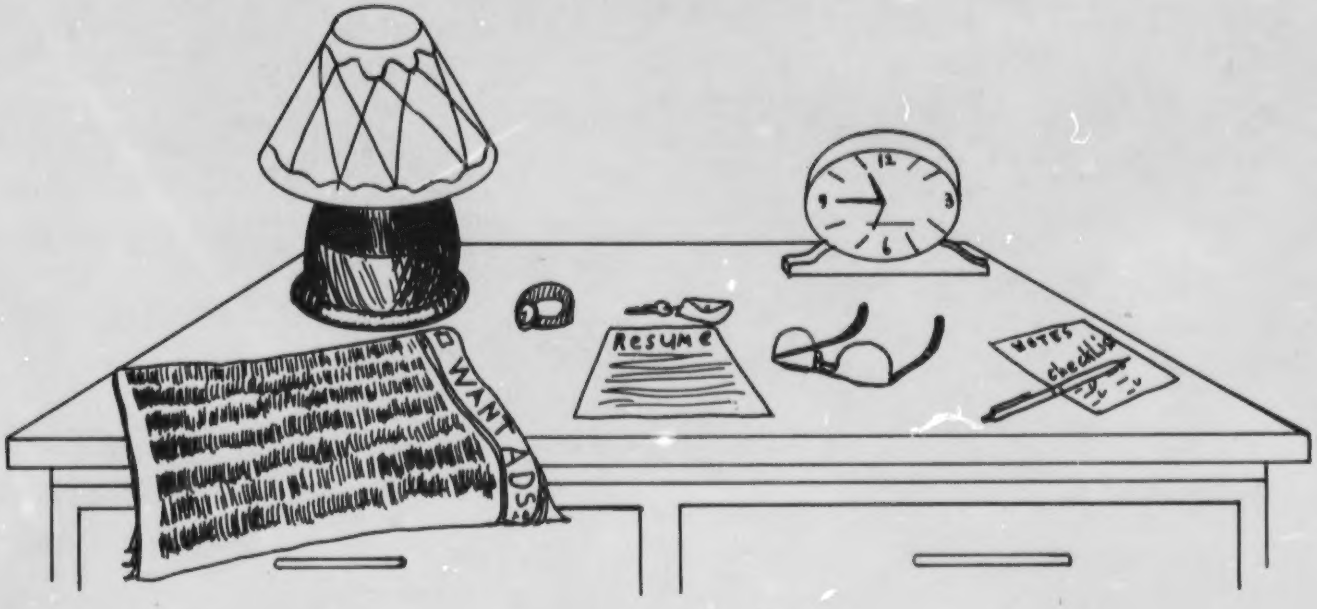
Clean shaven?

Clean and neat clothes?

Pen and paper?



Take the Time to be on Time



APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #1--WRITE A RESUME

Write a resume using accurate facts about yourself. Include the resume with a letter of application. Use the information below and the sample resume included in this assignment sheet as guides. A good resume should immediately give prospective employers a brief summary of your accomplishments, educational background, work experience, skills, and job objective. It is not necessary to use the exact wording and outline form used on the sample resume, but it is necessary that your resume be neat and balanced and contain all the information which might help you get a job. Keep a current copy of the resume and use it to apply for jobs.

1. Inspect several resume formats and choose one that best fits your needs or use the example included in this assignment sheet as a guide.

2. Type your resume on 8 1/2 x 11 inch white paper. Try not to exceed one page but attempt to fill the page.

3. Spell correctly. Many employers will not consider persons who have resumes that include misspelled words.

4. Put your name prominently at the top in the center or upper left-hand corner. Beneath name, give full street address, city, state, zip code, telephone number with area code, and a number where messages can be accepted.

5. Do not include birthplace, age, health, height, weight, sex, marital status, photo, salary, or reasons for leaving previous job. Avoid religious and political affiliations.

   (NOTE: In general, the more information you are willing to share the better. However, the whole point of the resume is to get employers interested to meet you in person. The above information may or may not come out in the interview. By not including this information there is little or no chance for discrimination because of race, color, religion, sex, or national origin.)

6. Describe your job objective or career goal briefly. Don't restrict yourself to a specific job unless you are experienced.

7. Describe your educational background, giving dates of enrollment, diploma or degrees received, and names of schools attended. Include grade average (if favorable) and major course of study. If you include school grades, be sure they are related to the jobs you have in mind.

   (NOTE: Applicants with less than one year of work experience should list education before work experience; with more than one year, put experience first. IN RESUME WRITING, ACCENTUATE THE POSITIVE, ELIMINATE THE NEGATIVE. If pertinent, mention additonal courses, scholarships, or summer school.)

ASSIGNMENT SHEET #1

8. List your past employment, starting with your most recent job. Carefully examine all your jobs--including extracurricular activities. CONCENTRATE ON THE SKILLS; DON'T CATEGORIZE "SUMMER JOBS."

   (NOTE: The list should include the name of the company, your job title, and your major duties. The starting and termination dates for each job should be listed. Most employers ask during interviews why you left previous jobs. Try to be positive in stating your reasons for leaving a former job. Do not downgrade your previous employers.)

9. List skills useful to the job. Remember, you have to prove your value to the business, especially if you have little experience.

   (NOTE: Use active verbs to indicate the specific tasks you performed, e.g., built, assisted, operated.)

10. Include the following information if it is relevant and if there is enough space: hobbies and interests, extracurricular activities, clubs, awards you have received.

11. Ask at least three persons for recommendations; ask yourself the kinds of recommendations they will give you.

    Examples: Business references, teachers, character references

    (NOTE: Avoid listing relatives unless you have actually worked for them on a salary basis. Include some method for prospective employer to acquire references.)

12. Write "Confidential" at the top of the resume if you don't want your current employer to know you're looking for employment.

    (NOTE: Your resume's physical appearance is VERY IMPORTANT. Be sure to proofread the printer's work. Always bring extra copies to interview. Leave one copy of resume with interviewer and use one as a reference when filling out the application form. You should also mail one resume with your letter of application.)

ASSIGNMENT SHEET #1

SAMPLE RESUME

Terry McKracken

Address:

Present	Permanent
774 E. Adams Street Yourtown, Yourstate 77704 405-311-7779	Route #3 Anytown, Yourstate 77702 405-235-4433

Job Objective: Career in air conditioning and refrigeration leading to supervisory position in this field

Education: Anytown High School, Anytown, Yourstate 1977-1981

Progress Vo-Tech, Progressville, Yourstate 1979
Certificate: Air Conditioning, four semesters
Grade average: 3.5 on a 4.0 scale

Subjects Studied:
Vocational Air Conditioning and Refrigeration Class 1980-81, all phases of air conditioning
Algebra--Two semesters
Geometry--Two semesters
Basic drafting--Two semesters
Industrial arts woodworking--Two semesters

Student Activities:
President, Senior Class
President, VICA
Treasurer, Baptist Youth Fellowship Organization
Air Conditioning contest, First Place State, Third Place National

Work Experience:
Service helper, Jones Air Conditioning Company, Summer 1979
Vocational Air Conditioning, 1978-79, all phases of repair
Mr. Sammy Slavedriver, Instructor

References: (with Permission)
Mr. Sammy Slavedriver
Vocational Air Conditioning and Refrigeration Instructor
Progress Vo-Tech
Progressville, Yourstate 77703

Mr. John Naildriver
Supervisor
Jones Air Conditioning Company
Anytown, Yourstate 77702

Mrs. Jerri Smith
Youth Director
Parkview Baptist Church
711 Fellowship Circle
Anytown, Yourstate 77702

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #2--WRITE A LETTER OF APPLICATION

The application letter is a sales technique to tell the employer how your abilities will be useful to the business. The letter should specify your qualifications while the resume gives general background information.

Cut a help-wanted ad for an air conditioning and refrigeration job from the classified ad section of the local paper. Write an application letter to accompany the resume you prepared in Assignment Sheet #1. Use the following information and the sample letter as a guide.

(NOTE: If you cannot type, it is recommended that you write or print NEATLY using blue or black ink.)

1. Use acceptable form and appearance
    a. Type or write neatly
    b. Write on only one side of the paper
    c. Avoid smudges and typographical errors
    d. Use 8 1/2" x 11" white bond paper, not personal or fancy paper
    e. Spell, capitalize, and punctuate correctly
    f. Put employer's full name, title, and address
    g. Include your full name and address with zip code on the letter
    h. Retain a copy for further reference
2. Include proper information
    a. Write to a specific person

       (NOTE: Find out the name of the personnel manager/employer you want to reach and the correct title. When in doubt, write to the top person who will refer your resume to the right party. Use *To Whom It May Concern* if answering a blind ad.)
    b. Avoid excessive use of the pronoun "I"
    c. Be brief; do not repeat information in the resume
        1) State the position for which you are applying
        2) Avoid needless details

ASSIGNMENT SHEET #2

3) Cover all points requested in the advertisement in exactly the order in which they were asked

(NOTE: Some prospective employers make it a point of testing the applicant's ability to follow directions.)

d. State reason for interest in job

(NOTE: Employers look for people who look for future advancement opportunities rather than just a paycheck.)

e. Refer briefly to the main points in the attached resume

f. Mention that persons listed on the resume have given their permission to serve as references

g. Request interview at employer's convenience

1) Tell where you can be reached

2) Enclose self-addressed envelope and resume

3) Say you will phone next week

3. Be original in your approach--Attract attention in opening paragraph

Examples:

Dear Mr. Money:

My experience related to air conditioning would be of interest to you.

Dear Ms. Owner:

Mr. Co-worker informed me that you are in need of a person who can be an air conditioning mechanic's helper. I believe that my experience and training have taught me how to handle these duties efficiently and accurately.

4. End the letter properly

(NOTE: *Sincerely yours* or *Very truly yours* is appropriate.)

5. Use permanent address for the return address and make sure to include the current date

6. Staple letter to resume as it may be circulated to several departments and otherwise become detached

---

ASSIGNMENT SHEET #6

SAMPLE FOLLOW-UP LETTER

Route #3
Anytown, Yourstate 77702
July 1, 1980

Mr. John Jones
Personnel Director
Jones Air Conditioning Company
Box 19
Yourtown, Yourstate 77704

Dear Mr. Jones:

Thank you for interviewing me for the job of air conditioning mechanic with your company. I feel that working for Jones Air Conditioning Company would be enjoyable and that I could do the general service work that the job requires. I hope that I will have the opportunity to prove my worth.

The application form you gave me is enclosed.

I will be available for work May 15. You may call me at my home after 3:30 p.m. The number 405-235-4433.

Sincerely yours,

Terry McKracken

Encl.

ASSIGNMENT SHEET #2

7. Follow up and phone for an appointment a week later

   (NOTE: Don't be surprised if the resume has been referred to another department. Remember, they are in business and you may not get immediate attention, especially if you sent a blind letter. Be persistent until you reach the right person and ask for a convenient date to set up an interview.)

8. Keep in touch regarding possible openings now and in the future

   (NOTE: The "job hunt" may take several weeks or even months; it's important to keep your contacts alive without being a nuisance.)

ASSIGNMENT SHEET #2

SAMPLE LETTER OF APPLICATION

Route #3
Anytown, Yourstate 77702
June 15, 1982

Mr. John Jones
Personnel Director
Jones Air Conditioning Company
Box 19
Yourtown Yourstate 77704

Dear Mr. Jones:

Please consider me for the Air Conditioning and Refrigeration job that you advertised in the *Daily Chronicle*.

The skills I have learned in my high school vocational air conditioning courses should qualify me for this job. I have had experience in all of the basic skills required by the air conditioning trade, including the safe use of power tools.

I will be graduated from high school in May, and I would like to become an air conditioning maintenance person. A more complete description of my qualifications is given in the enclosed resume.

I would appreciate the opportunity to come and talk over this job opportunity at your convenience. I can be reached by telephone at 405-235-4433 after 3:30 or at the above address.

Sincerely yours,

Terry McKracken
Encl.

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #3--COMPLETE AN EMPLOYMENT APPLICATION FORM

Complete the following application form using the guidelines below. Use information corresponding to the classified ad and to your letter of application. Use information about yourself from your resume.

(NOTE: Although each business uses its own form, general rules of preparation apply to any form.)

1. Be prepared
   a. Take a good ink pen with you
   b. Take copies of resume
2. Look over entire form before starting to write; do not hurry
3. Follow directions
   a. Note whether information is to be printed or handwritten
   b. Carry out all directions
4. Write clearly, neatly, and legibly
5. Answer briefly
6. Be honest
7. Answer all questions

   (NOTE: If questions do not apply to you, write *Not Applicable* or *NA* in the space to show that you did not overlook the question.)
8. Include complete information; use resume
9. Recheck application when finished
10. Avoid cross-outs and obvious erasure marks
11. Do not list any restrictions to the geographical area in which you would work unless you absolutely will not consider other geographical areas
12. Use the word "open" for questions about minimum salary since most employers pay standardized rates and will not negotiate on this

"WE ARE AN EQUAL OPPORTUNITY EMPLOYMENT COMPANY. WE ARE DEDICATED TO A POLICY OF NON-DISCRIMINATION IN EMPLOYMENT ON ANY BASIS INCLUDING RACE, CREED, COLOR, AGE, SEX, RELIGION OR NATIONAL ORIGIN OR PHYSICAL DEFECTS."

APPLICATION FOR EMPLOYMENT

PERSONAL INFORMATION

DATE

NAME
LAST FIRST MIDDLE

PRESENT ADDRESS
STREET CITY STATE ZIP

PERMANENT ADDRESS
STREET CITY STATE ZIP

PHONE NO. SOCIAL SECURITY NUMBER

REFERRED BY

EMPLOYMENT DESIRED

POSITION DATE YOU CAN START SALARY DESIRED

ARE YOU EMPLOYED NOW? IF SO, MAY WE INQUIRE OF YOUR PRESENT EMPLOYER

EVER APPLIED TO THIS COMPANY BEFORE? WHERE WHEN

EDUCATION	NAME AND LOCATION OF SCHOOL	YEARS ATTENDED	DATE GRADUATED	SUBJECTS STUDIED
GRAMMAR SCHOOL				
HIGH SCHOOL				
COLLEGE				
TRADE, BUSINESS, OR CORRESPONDENCE SCHOOL				

SUBJECTS OF SPECIAL STUDY OR RESEARCH WORK

U.S. MILITARY OR NAVAL SERVICE RANK PRESENT MEMBERSHIP IN NATIONAL GUARD OR RESERVES

ACTIVITIES OTHER THAN RELIGIOUS (CIVIC, ATHLETIC, FRATERNAL, ETC.)

Exclude organizations, the name or character of which indicates the race, creed, color, or national origin of its members.

LAST
FIRST
MIDDLE

(CONTINUED ON OTHER SIDE)

ACR III - 45

FORMER EMPLOYERS (LIST BELOW LAST FOUR EMPLOYERS, STARTING WITH LAST ONE FIRST.)

DATE MONTH & YEAR	NAME AND ADDRESS OF EMPLOYER	SALARY	POSITION	REASON FOR LEAVING
FROM				
TO				
FROM				
TO				
FROM				
TO				
FROM				
TO				

REFERENCES: Give below the names of two persons not related to you, whom you have known at least one year.

	NAME	ADDRESS	BUSINESS	YEARS ACQUAINTED
1				
2				

PHYSICAL RECORD:

List any physical defects

WERE YOU EVER INJURED? GIVE DETAILS

HAVE YOU ANY DEFECTS IN HEARING? IN VISION? IN SPEECH?

IN CASE OF EMERGENCY NOTIFY

NAME ADDRESS PHONE NO.

I AUTHORIZE INVESTIGATION OF ALL STATEMENTS CONTAINED IN THIS APPLICATION. I UNDERSTAND THAT MISREPRESENTATION OR OMISSION OF FACTS CALLED FOR IS CAUSE FOR DISMISSAL. FURTHER, I UNDERSTAND AND AGREE THAT MY EMPLOYMENT IS FOR NO DEFINITE PERIOD AND MAY, REGARDLESS OF THE DATE OF PAYMENT OF MY WAGES AND SALARY, BE TERMINATED AT ANY TIME WITHOUT ANY PREVIOUS NOTICE.

DATE SIGNATURE

DO NOT WRITE BELOW THIS LINE

TO BE COMPLETED DAY EMPLOYMENT BEGINS DATE

HEIGHT WEIGHT AGE DATE OF BIRTH

SINGLE MARRIED WIDOWED CITIZEN U.S.A. SEX

THE ABOVE INFORMATION NEEDED FOR PENSION, HOSPITALIZATION, INSURANCE, ETC., AND NOT FOR HIRING PURPOSES

INTERVIEWED BY DATE REMARKS

NEATNESS		CHARACTER	
PERSONALITY		ABILITY	

HIRED FOR DEPT. POSITION WILL REPORT SALARY WAGES

APPROVED: 1. 2. 3.

EMPLOYMENT MANAGER DEPT. HEAD GENERAL MANAGER

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #4--PRACTICE ANSWERING INTERVIEW QUESTIONS

The following are some additional questions which might be asked when applying for various jobs. Keep the assignment sheet to review before going on any actual interview.

(NOTE: Questions about your personal life may not legally be asked. In fact, it is illegal for an employer to ask your maiden name or your father's surname if you are a female applicant; your marital status; who lives with you; the church you attend or the name of your spiritual leader; how many children you have, their ages, or who will care for them while you are at work; whether you own or rent your residence; whether you have ever had your wages garnisheed; and whether you have ever been arrested. However, many interviewers, particularly in smaller businesses, may ask such questions. Whether or not you chose to answer the questions depends on how badly you want the job.)

How would you answer the following questions? Why do you think each question might be asked?

1. Where do you go to school? When will you graduate?
2. Do you (did you) earn any of your own expense money while in school?
3. Why did you leave your previous job(s)?
4. What did you like best and what did you like least about your classes?

   (NOTE: This could be asked about teachers, jobs, or employers.)
5. What books have you read lately? What are your favorite magazines?
6. Are you in good health?
7. What do you expect to be doing five or ten years from now? What is your chosen field of work?
8. At what salary do you expect to start?
9. What are some of your special abilities? What skills do you possess? What tools or equipment can you operate?
10. How would you rate your training for this job? Very good? Fair?
11. What personal characteristics do you think are needed to succeed in your vocation?

ASSIGNMENT SHEET #4

12. In what area do you need the most improvement?

13. Do you like to work with other people or do you work best alone?

14. Do you have any questions you want to ask us?

15. Do you think your extracurricular activities were worth the time you devoted to them?

16. How could you contribute to our organization? Why should we hire you?

17. Tell us about your family and any plans for marriage or further education.

    (NOTE: REMEMBER: Legally, you do not have to answer this question. However, it is a good idea to prepare an answer in case such a question is asked.)

18. For what other jobs have you applied?

19. Do you have any military obligations to fulfill?

20. Give us an example of a project you finished under pressure.

21. May we write or call your last employer?

22. How many people have you supervised at work or through organizations of which you are a member?

23. How do you feel about the progress you have made salary-wise?

24. Would you be able to work all day Saturday and Sunday?

25. If you could start school (or work) over again what would you do differently?

26. What is your school attendance record?

27. Have you done the best school work of which you are capable?

28. Do you require attention? Does criticism disturb you?

    (NOTE: These questions are usually asked in a more subtle and indirect way.)

29. What motivates you?

30. Would you be willing to relocate?

31. What size city do you prefer?

ASSIGNMENT SHEET #4

32. Have you saved any money?

33. Define *cooperation*.

34. What job with our company would you choose if you were entirely free to do so?

35. How do you feel about working overtime?

REMEMBER: YOU NEVER GET A SECOND CHANCE TO MAKE A GOOD FIRST IMPRESSION!!! GETTING A JOB IS A JOB!!!

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #5--MAKE AN APPOINTMENT BY PHONE FOR A JOB INTERVIEW

Making an appointment by phone does two things. First, it shows that you are interested in saving the employer's time. Second, it shows that you are thoughtful for asking what would be the best time for you to see the employer.

1. Steps in making an appointment by phone
    a. Plan what you are going to say before you call
    b. State your name and reason for calling

       Example: "Hello, this is Terry McKracken. I'm calling about your ad in last night's paper for an air conditioning mechanic. May I have an appointment for an interview?"

    c. Ask when would be the best time for you to come for the interview
    d. Record the day, time, and place of the interview
    e. Thank the receptionist for the help
2. Things to remember when calling for an appointment
    a. Keep the receptionist on your side; the receptionist is there to help you

       (NOTE: The receptionist is sometimes asked to evaluate the applicant.)

    b. Do not ask over the phone how much the job pays
    c. Be polite and courteous

       (NOTE: Remember that this call is the first contact you may have with the firm. Make that first impression a good one.)

    d. Ask if you should pick up an application blank or if they would like to send it to you before the interview

Now that you have read about the correct way to arrange for a job interview, role play a situation where you make an appointment by phone. Use the checklist on the next page to evaluate your performance.

ASSIGNMENT SHEET #5

	YES	NO
Was prepared before calling		
Did not have to stammer to find the right words		
Identified self immediately		
Stated reasons for calling immediately		
Asked the best time for an appointment with employer		
Was courteous and friendly		
Asked about picking up application blank or having application blank sent prior to interview		
Thanked the receptionist		
Made record of the interview date, hour, and place		

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #6--WRITE A FOLLOW-UP LETTER OR MAKE A FOLLOW-UP PHONE CALL AFTER INTERVIEWING FOR A JOB

It is sometimes helpful to return to a business and check again on possible job openings. This is often done about a week after the first interview. This short casual visit accomplishes two things. It helps the interviewer remember you, and it shows that you have a sincere interest in working for that company.

However, it is not always possible to have this type of informal atmosphere when applying for a job, in which case it is always proper to send a follow-up letter or make a follow-up telephone call.

PART A

Write a follow-up letter thanking the employer for the interview. Use any form you wish or follow the format of the sample follow-up letter included in the assignment sheet.

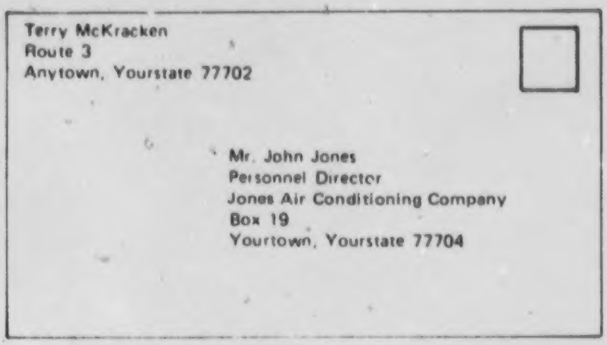
1. Make sure your letter meets the following standards
    a. Typed or written perfectly
    b. Clean, neat, and attractively arranged on the page
    c. Free from spelling, punctuation, and grammatical errors
    d. Sent within a day or two after the interview
2. Include the following points in your follow-up letter
    a. Expression of appreciation for interviewer's time and interest
    b. Summary of your qualifications and interest in position
    c. Your name, address, and phone number (to make it easier for the employer to contact you)
3. Make this last bid for the job a prime example of your excellent work habits; make the letter clean, neat, and well-worded

ASSIGNMENT SHEET #6

4. Address a legal-sized envelope (Figure 1)

   (NOTE: Be sure and type the address EXACTLY the same as the inside address of the letter.)

FIGURE 1



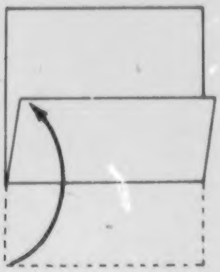
Terry McKracken
Route 3
Anytown, Yourstate 77702

Mr. John Jones
Personnel Director
Jones Air Conditioning Company
Box 19
Yourtown, Yourstate 77704

5. Fold letter

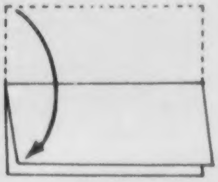
   a. Fold slightly less than one-third of the letter toward the top (Figure 2

FIGURE 2



   b. Fold down the top of the letter to within 1 cm (1/2") of the bottom fold (Figure 3)

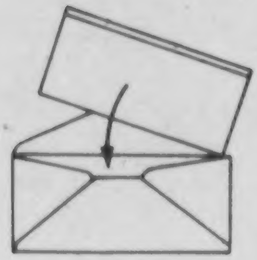
FIGURE 3



ASSIGNMENT SHEET #6

6. Insert the letter into the envelope with the last crease toward the bottom of the envelope (Figure 4)

FIGURE 4



PART B

Role play a follow-up telephone call using the guidelines below.

1. Make sure you include the following information
   a. Your name
   b. Date of your interview
   c. Position for which you were interviewed
2. Ask whether a decision has been made

Example:	Incorrect:	"Hello, Mr. Jones. This is Terry McKracken. You told me you would let me know about the job, but I haven't heard anything from you. Why haven't you called me?"
	Incorrect:	"This is Terry McKracken. Did I get the job?"
	Correct:	"Hello, Mr. Jones. This is Terry McKracken. I interviewed with you on June 30th for the position of a helper. Have you made a decision on my application yet?"

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #7–EVALUATE A JOB OFFER

Instead of saying "yes" or "no" on the spot to a job offer, express your gratitude in a warm and friendly manner, and then ask if you may have time to consider the opportunity you have been offered. Few reputable employers will deny you a reasonable time to be certain before agreeing to take a job.

Avoid getting stuck with a job that's wrong for you by using the following checklist to evaluate the job offer.

THE JOB . . .

Do I clearly understand the nature of the work and is it what I want to do? Are my responsibilities reflected in the job title?

If this isn't my dream job, can it be a stepping stone as I acquire the skills and experience needed for advancement?

Is the background I'm building so narrow that I will have difficulty transferring it to another employer?

Will I be able to make any decisions affecting my work? Do I care?

Will I need more training and will the company pay for it?

Will overtime be necessary or available?

Will I be able to leave all thought of the job behind at day's end? If not, do I care?

Will I have to travel or relocate?

Is the job permanent or temporary?

If permanent, is there reasonable job security?

Does this job require union membership?

THE COMPANY . . .

Is the firm too large and heavy with rules for my personality?

Is the firm too small to offer room for advancement or impressive credentials for a future resume?

ASSIGNMENT SHEET #7

Does the firm have a healthy financial position and is it a growing organization?

Is there a high turnover of personnel, and if so, why?

Does the firm promote from within the ranks or turn to outsiders to fill supervisory jobs?

Have I met the person who would be my immediate supervisor?

Does the supervisor seem like the sort of person with whom I could get along?

Do co-workers appear to be my kind of people?

Is the company's location convenient?

What is the firm's reputation for fair treatment of employees?

Is a written personnel statement available that covers vacations, sick leave, cause for dismissal, and so forth?

FINANCIAL REWARDS . . .

Do the earnings meet my minimum needs? Are there automatic cost-of-living increases?

What is the method of payment--salary, hourly wage?

Are raises based on merit, length of service, formal exams?

What fringe benefits are given--health insurance, free parking, discount privileges, and others?

WHEN TO SAY NO . . . Should you always turn down an offer that doesn't measure up?

That depends on several questions. How desperately do you need to earn money? How competitive is the field you hope to enter, and would it be best to get your foot in the door any way you can? How valuable is the experience you'll gain? There are times when it is wise to accept a job which is not perfect in your estimation.

On the other hand, it could be best to refuse the offer.

Adapted from "If Things Don't Shape Up, I May Not Take the Job," Career World, February, 1977.

APPLYING FOR A JOB
UNIT II

ASSIGNMENT SHEET #8--COMPARE JOB OPPORTUNITES

When you are offered a job or are changing jobs there are many factors to weigh before taking the position. Some of these include:

- What is your take-home pay?
- What are the benefits which accompany the job?
- How much will it cost to actually be at work each day?
- Would the job be satisfying to you?
- How would the job meet your needs and aspirations?

WHAT'S MY TAKE-HOME PAY?

Salaries and wages are often quoted by employers as gross earnings. Gross earnings are used because tax deductions vary due to the number of dependents, the amount of earnings, and other information.

Optional benefits and deductions offered by an employer also differ. It is generally advisable to ask what programs are available for enrollment as these can affect the actual money you receive on pay day.

ASSIGNMENT SHEET #8

WHAT OTHER BENEFITS DO I GET FROM THIS JOB?

Some benefits associated with working are not always visible. Often some of these overlooked benefits are paid for in part by your employer. At the time of the interview or when considering a positon ask about:

- Employer's contributions for your protection which may include:
  - Health insurance
  - Unemployment compensation
  - Clothing and safety garments
  - Medical facilities and health tests
  - Pensions
  - Travel insurance (covering mishaps when traveling on business)
  - Educational programs or reimbursement for courses related to job
- Sick leave with pay
- Paid vacations and holidays

WHAT WILL IT COST TO WORK AT THIS JOB?

Frequently, we often overlook the costs which are associated with being employed. It may be of value to calculate estimated weekly expenses before you make a decision about a job.

Estimate weekly expenses for:

Transportation (parking, bus fares) $_____

Lunches (or cost of food eaten away from home, including soft drinks and coffee) $_____

Clothing (including cleaning) $_____

Child care for working parent $_____

Gifts for other employees $_____

Special uniforms, materials, or equipment for job $_____

Other $_____

TOTAL $_____

ASSIGNMENT SHEET #8

WHAT IS IMPORTANT TO ME IN A JOB?

Take-home pay and benefits may be only part of what you want from a job. Think through other things you consider important in a job.

What are some of the most rewarding things you've felt about any job you've ever had?

1. ____________________
2. ____________________
3. ____________________

How might you rate these in order of what's important to you?

_____ Job security (little chance you'll be released from the job)

_____ Opportunity for advancement

_____ Recognition for your work

_____ Good wages

_____ Opportunity to learn and use your ideas

_____ Flexible working hours

_____ Long vacations

_____ Pleasant working conditions

_____ Interesting work

_____ Friendly co-workers

_____ Other, such as ____________________

ARE YOU READY TO DECIDE????

Take all the information you have gathered and summarize it below and on the next page to reach a decision about whether you want the job or not.

1. Would the job be satisfying to you? Why/why not?

____

____

____

ASSIGNMENT SHEET #8

2. What are the benefits which accompany the job?

____

____

____

____

3. How much will it cost to actually be at work each day?

____

____

____

4. How would the job meet your needs and aspirations?

____

____

____

5. I estimate my take-home pay to be $__________.

6. I estimate my expenses related to working to be $__________.

7. I would most enjoy the following about this job: __________

____

____

8. I estimate my job benefits to be worth $ __________.

APPLYING FOR A JOB
UNIT II

NAME ______________________________

TEST

1. Match the terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. Brief, typed summary of one's qualifications and experience that is used in applying for a job

_____b. Extras provided by an employer, such as paid vacations, sick leave, and insurance protection

_____c. Recognition received for outstanding achievement

_____d. Experience, education, and physical characteristics which suit a person to a job

_____e. Any vocational courses and skills one has learned in high school or through work experience

_____f. Clubs, organizations, and social or church groups in which one participates

_____g. To attach wages or other property to satisfy a debt

_____h. Meeting of employer and job applicant for purpose of evaluation and questioning

_____i. Printed form on which job applicants record information about their personal history, job history, job experience, education, and references

_____j. Business that is designed to help individuals find employment

_____k. Classified advertising that does not identify the advertiser

_____l. Classified advertisement placed by individuals seeking employment and telling what their qualifications are

1. Award
2. Interview
3. Extracurricular activities
4. Fringe benefits
5. Application form
6. Qualifications
7. Resume
8. Garnishee
9. Vocational preparation
10. Employment agency
11. Equal opportunity employer
12. Blind ad
13. Help wanted ad
14. Legible
15. Employment/situation wanted ad

_____m. Classified advertisement telling what kind of job is available and what the qualifications are

_____n. Capable of being read; clear

_____o. Employer who is making a special effort to assure that no form of discrimination is practiced

2. List four means of locating job openings.

   a.

   b.

   c.

   d.

3. List three methods of applying for a job.

   a.

   b.

   c.

4. Select personal attributes or attitudes an employer looks for during a personal interview by placing an "X" in the appropriate blanks.

_____a. Alertness, quickness of mind

_____b. Long wavy hair

_____c. Dedication and dependability

_____d. Enthusiasm and interest

_____e. New car

_____f. Honesty and integrity

_____g. Desire to work

_____h. Beard

_____i. Flashy clothes

_____j. Desire to help others

_____k. Desire to improve one's self

5. Select guidelines for dressing for an interview by placing an "X" in the appropriate blanks.

______a. Kind of job

______b. Salary range

______c. What employer is wearing on the job

______d. Age of the interviewer

______e. Age of the interviewee

______f. Wear highly fashionable clothing

______g. Be modest and well-groomed

6. List four items which an applicant may need to prepare when applying for a job.

a.

b.

c.

d.

7. Select guidelines to follow when participating in a job interview by placing an "X" in the appropriate blanks.

______a. Take parents or friends with you to job interview

______b. Know facts about the business

______c. Start the interview with a smile and greet the interviewer by name

______d. Place personal things, such as coat, hat, or purse, on interviewer's desk

______e. Criticize former employers or competitors when applicable

______f. State that you are willing to start at the beginning salary

______g. Answer all questions honestly

______h. Ask questions about politics, economics, religion, and other controversial subjects

______i. Look directly at interviewer

______j. Do not ask questions or show interest in the business _____k. Thank interviewer for his/her time

_____l. Write thank you letter, call, or visit again to express interest in the job and appreciation for the opportunity to interview

8. Write a resume.
9. Write a letter of application for a job.
10. Complete employment application form for a job.
11. Practice answering interview questions.
12. Make an appointment by phone for a job interview.
13. Write a follow-up letter or make a follow-up phone call after interviewing for a job.
14. Evaluate a job offer.
15. Compare job opportunities.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

APPLYING FOR A JOB
UNIT II

ANSWERS TO TEST

1. a. 7
   b. 4
   c. 1
   d. 6
   e. 9
   f. 3
   g. 8
   h. 2
   i. 5
   j. 10
   k. 12
   l. 15
   m. 13
   n. 14
   o. 11

2. Any four of the following:

   a. Classified ads
      1) Newspapers
      2) Magazines
   b. Employment offices
      1) Department of Labor
      2) Private
   c. Local labor union business office
   d. School officials
      1) Teacher
      2) Counselor
      3) Principal

3. a. Letter
   b. Telephone
   c. In person

4. a, c, d, f, g, j, k

5. a, b, g

6. a. Resume
   b. Letter of application
   c. Application form
   d. Follow-up letter

7. b, c, g, i, k, l

8. Evaluated to the satisfaction of the instructor

9. Evaluated to the satisfaction of the instructor

10. Evaluated to the satisfaction of the instructor

11. Evaluated to the satisfaction of the instructor

12. Evaluated to the satisfaction of the instructor
13. Evaluated to the satisfaction of the instructor
14. Evaluated to the satisfaction of the instructor
15. Evaluated to the satisfaction of the instructor

CUSTOMER RELATIONS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the ways individual work habits contribute to good customer relations, and list solutions for special problems in customer relations. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to customer relations with their correct definitions.
2. List ways good personal habits contribute to good customer relations.
3. Select true statements concerning general rules in dealing with customers.
4. Select true statements concerning basic rules for service calls.
5. List ways to turn service calls into good customer relations opportunities.
6. Select true statements concerning ways to handle an irritated customer.
7. List ways vehicle operations affect customer relations.
8. List ways to earn a customer's respect.
9. Respond to problem situations.

CUSTOMER RELATIONS
UNIT III

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information sheet.

III. Discuss unit and specific objectives.

IV. Invite a local air conditioning and refrigeration contractor to talk to the class concerning the value of good customer relations.

V. Invite an experienced service person to talk to the class concerning customers and some of the unusual problems that can be encountered on service calls.

VI. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Assignment Sheet #1--Respond to Problem Situations

   D. Answers to assignment sheet

   E. Test

   F. Answers to test

II. References:

   A. Russell, Allen. *Getting Started in Heating and Air Conditioning Service*. Birmingham, MI: Business News Publishing Company, 1973.

   B. Fruehling, Rosemary T. *Working at Human Relations*. New York: Gregg Division/McGraw-Hill Book Company, 1977.

   C. Taylor, Mark. *Residential Wiring*. Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1978.

CUSTOMER RELATIONS
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Customer relations--The personal on-the-job performance and related activities by business owners and their employees that instill in a customer a sense of value, satisfaction, and trust

   B. Personal hygiene--The attention a person pays to habits that promote cleanliness, good health, and psychological well being

   C. Word-of-mouth advertising--What customers or clients of a business or service tell their friends about the service they received or the product they bought

II. Ways good personal habits contribute to good customer relations

   A. Every hour you're on the job, your appearance and behavior contribute to the company image

   B. Off the job, positive remarks about your work and your company contribute to good customer relations

   (NOTE: Positive word-of-mouth advertising is the best kind of advertising, and it not only comes from satisfied customers, it can also be generated by concerned employees.)

   C. Personal hygiene not only contributes to good personal appearance, it creates a psychological well being needed in dealing with daily stress and many different types of customers

   D. Good work habits begin with being on time and help contribute to the accurate and efficient work that impresses and satisfies customers

   E. Respect for company vehicles and equipment reflects a concern that customers unconsciously relate to

   F. Respect for customer property inspires customer respect in return

III. General rules in dealing with customers

   A. Be courteous at all times, especially when circumstances have created an unpleasant situation

   (NOTE: It's easy to be courteous when things are going well; it takes character to be courteous in tough situations.)

   B. Treat all service calls as emergencies

   (NOTE: Except for maintenance, most service calls are made to correct situations that are causing people inconvenience or discomfort.)

INFORMATION SHEET

C. Respect scheduling commitments

(NOTE: If unexpected problems on one call mean you'll be late getting to a second scheduled call, phone the second customer or have the office phone to explain the delay and set a new time.)

D. Keep your personal problems to yourself; you're there because the customer has problems

E. Avoid socializing after the job is done; time spent drinking coffee or iced tea with a customer can be used to better personal and company advantage

F. Never make commitments to a customer without company approval

IV. Basic rules concerning service calls

A. Check the truck to make sure you won't be leaving a track of mud or leaking oil on a customer's driveway

B. Check your own appearance and make sure your feet are clean

C. Identify yourself, your company, and state that you are there to service a specific problem

(NOTE: Many service calls are made during times when a housewife is home alone; proper identification eases anxieties associated with inviting strangers into the home.)

D. Politely ask questions to establish what the problem is, when it started, how many times it has happened, and at what times of day it is most noticeable

E. Tell the customer you have an idea of what the problem is and can probably have the equipment in operation again in a short while

(NOTE: Don't pinpoint the problem because it could turn out to be something else and cause the customer to doubt that you know what you're doing.)

F. When the work is finished, make sure the work area is clean and that all parts and covers are back in place

G. Assure the customer that the equipment is working well and explain what caused the failure and anything the customer can do to help prevent its happening again

H. Even if billing is done from the office, tell the customer what was wrong, what replacement parts you used, and leave the old parts for the customer to examine

INFORMATION SHEET

V. Ways to turn service calls into good customer relation opportunities

  A. Leave the company name and telephone number with the customer; if the company has a sticker, suggest it be placed in the front of the phone book with the emergency numbers

  B. Show the customer how easy it is to change filters and explain how clean filters improve equipment performance and save money and energy

  C. Show the customer proper thermostat operation, especially if the thermostat has an energy-saving design

  (NOTE: When these activities are completed after the bill is presented, it leaves the customer with a feeling that you have contributed an extra service free of charge--and you have.)

VI. Ways to handle an irritated customer

  A. Show your concern by listening carefully

  B. Show your concern by taking notes of specific items in the complaint; this helps keep the matter on a business level

  C. Let the customer state the entire problem

  (NOTE: Call it "blowing off steam" or " getting it out of your system," this usually permits a customer to cool off.)

  D. In cases where the situation involves equipment still under warranty, assure the customer that the part will be replaced free of charge and that the job will be given priority status

  E. In cases where the situation involves a misunderstanding concerning an entire contract, assure the customer that a salesman or the company owner will contact them as soon as possible

  (NOTE: In these cases, it is wise to call the office immediately and try to set a specific day and hour for the meeting.)

  F. Apologize for any inconvenience and assure the customer that the company will correct the matter as soon as possible

VII. Ways vehicle operations affect customer relations

  A. Trucks and vehicles with the company name on them are mobile advertisements and should be kept clean and in good repair

  B. Trucks and vehicles should be driven safely and courteously; accidents or even incidents create a damaging public image

  C. Intoxicants, drugs, profanity, and horseplay do not belong around business, and especially not around company vehicles

INFORMATION SHEET

VIII. Ways to earn a customer's respect

A. Wear clean clothes or a clean uniform daily

B. Always carry a cleaning rag to wipe greasy fingerprints off thermostats or equipment covers

C. Carry a drop cloth to use in situations where dust or dirt might fall on a carpet or a finished hardwood floor

D. Do not smoke while on a service call

CUSTOMER RELATIONS
UNIT III

ASSIGNMENT SHEET #1--RESPOND TO PROBLEM SITUATIONS

Directions: Based on information contained in this unit, respond in writing or role play the method you would use to relate to specific problem situations with customers.

1. The customer is pleased that you repaired the air conditioner in less than an hour, and invites you to coffee and doughnuts. What is the best response?
2. You are on a service call and realize that you are going to be only 20 minutes late to your next service call. What is the best response?
3. You are on a service call in a situation where the customer is not at home, and an early check of the problem indicates that repairs will cost a great deal more than the customer is probably anticipating. What is the best response?
4. The customer is pleased that you repaired the air conditioner in less than an hour, but indicates the unit is old and costing too much in repairs. At this point, the customer invites you to have a cup of coffee so he or she can ask some questions about new equipment. What is the best response?
5. You are sent on a service call at 2:30 in the morning and arrive to find that the only problem is that someone (maybe a child) has turned the thermostat down too low, and the customer jokes that surely there'll be no charge for correcting something that simple. What is the best response?
6. You are sent on a service call only to find that the customer is disturbed with the entire performance of equipment the company has installed, and is obviously irritated with the company, their work, and their service. The customer especially complains that the company has not lived up to its contract guarantees. What is the best response?

CUSTOMER RELATIONS
UNIT III

ANSWERS TO ASSIGNMENT SHEET #1

1. Indicate that you have other service calls to make, and politely excuse yourself from the invitation.

2. Even if you're only going to be a few minutes late, call the office and have someone inform the next customer that you're going to be a little late.

3. Contact the customer before you begin any repairs that will cost considerably more than the customer anticipates. If you cannot contact the customer personally, have someone at the office do it.

4. Anytime a customer indicates an interest in add-on or new equipment, take the time to listen to the problem and take notes, and make sure the information gets to the boss or the sales manager as soon as possible.

   (NOTE: It is common practice with many companies to pay service personnel cash bonuses for leads that result in sales of new equipment.)

5. The charge for service calls is set by the company. The customer should be told this as politely as possible as the bill is presented.

6. Hear the customer out, then contact the office and set up a date for the owner or a salesman to visit with the customer as soon as possible.

CUSTOMER RELATIONS
UNIT III

NAME ______________________________

TEST

1. Match the terms on the right with their correct definitions.

_____a. The personal on-the-job performance and related activities by business owners and their employees that instill in a customer a sense of value, satisfaction, and trust

_____b. The attention a person pays to habits that promote cleanliness, good health, and psychological well being

_____c. What customers or clients of a business or service tell their friends about the service they received or the product they bought

1. Personal hygiene
2. Word-of-mouth advertising
3. Customer relations

2. List four ways good personal habits contribute to good customer relations.

a.

b.

c.

d.

3. Select true statements concerning general rules in dealing with customers by placing an "X" in the appropriate blanks.

_____a. Be courteous at all times, especially when circumstances have created an unpleasant situation

_____b. Treat all service calls as emergencies

_____c. Respect scheduling commitments, but if you have to be late don't worry because people expect that

_____d. Keep your personal problems to yourself; you're there because the customer has problems

_____e. Take time to drink coffee or iced tea with a customer; this lets them know you're friendly

_____f. Never make commitments to a customer without company approval

4. Select true statements concerning basic rules for service calls by placing an "X" in the appropriate blanks.

______a. Check the truck to make sure you won't be leaving a track of mud or leaking oil on a customer's driveway

______b. Check your own appearance and make sure your feet are clean

______c. Identify yourself, your company, and state that you are there to service a specific problem

______d. Politely ask questions to establish what the problem is, when it started, how many times it has happened, and at what times of day it is most noticeable

______e. Tell the customer you know exactly what the problem is and can probably have the equipment in operation again in a short while

______f. When the work is finished, make sure the work area is clean and that all parts and covers are back in place

______g. Assure the customer that the equipment is working well and explain what caused the failure and anything the customer can do to help prevent its happening again

______h. Even if billing is done from the office, tell the customer what was wrong, what replacement parts you used, and leave the old parts for the customer to examine

5. List two ways to turn service calls into good customer relations opportunities.

a.

b.

6. Select true statements concerning ways to handle an irritated customer by placing an "X" in the appropriate blanks.

______a. Show your concern by listening carefully

______b. Show your concern by taking notes of specific items in the complaint; this helps keep the matter on a business level

______c. Do not let the customer state the entire problem; this is usually a waste of time

______d. In cases where the situation involves equipment still under warranty tell the customer the manufacturer will have to take care of it

______e. In cases where the situation involves a misunderstanding concerning an entire contract, assure the customer that a salesman or the company owner will contact them as soon as possible

______f. Apologize for any inconvenience and assure the customer that the company will correct the matter as soon as possible

7. List three ways vehicle operations affect customer relations.

   a.

   b.

   c.

8. List three ways to earn a customer's respect.

   a.

   b.

   c.

9. Respond to problem situations.

   (NOTE: If item 9 has not been completed prior to the test, ask your instructor when it should be completed.)

CUSTOMER RELATIONS
UNIT III

ANSWERS TO TEST

1. a. 3
   b. 1
   c. 2

2. Any four of the following:

   a. Every hour you're on the job, your appearance and behavior contribute to the company image

   b. Off the job, positive remarks about your work and your company contribute to good customer relations

   c. Personal hygiene not only contributes to good personal appearance, it creates a psychological well being needed in dealing with daily stress and many different types of customers

   d. Good work habits begin with being on time and help contribute to the accurate and efficient work that impresses and satisfies customers

   e. Respect for company vehicles and equipment reflects a concern that customers unconsciously relate to

   f. Respect for customer property inspires customer respect in return

3. a, b, d, f

4. a, b, c, d, f, g, h

5. Any two of the following:

   a. Leave the company name and telephone number with the customer; if the company has a sticker, suggest it be placed in the front of the phone book with the emergency numbers

   b. Show the customer how easy it is to change filters and explain how clean filters improve equipment performance and save money and energy

   c. Show the customer proper thermostat operation, especially if the thermostat has an energy-saving design

6. a, b, e, f

7. a. Trucks and vehicles with the company name on them are mobile advertisements and should be kept clean and in good repair

   b. Trucks and vehicles should be driven safely and courteously; accidents or even incidents create a damaging public image

   c. Intoxicants, drugs, profanity, and horseplay do not belong around business, and especially not around company vehicles

8. Any three of the following:

   a. Wear clean clothes or a clean uniform daily

   b. Always carry a cleaning rag to wipe greasy fingerprints off thermostats or equipment covers

   c. Carry a drop cloth to use in situations where dust or dirt might fall on a carpet or a finished hardwood floor

   d. Do not smoke while on a service call

9. Evaluated to the satisfaction of the instructor

BUSINESS MANAGEMENT
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the objectives of good business management and discuss the forms and processes that are used in good business management. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to business management with their correct definitions.
2. List objectives of good business management.
3. Select true statements concerning guidelines for maintaining inventory control.
4. Select true statements concerning guidelines for maintaining records of installations, service calls, and maintenance calls.
5. List ways to gather information for a good equipment file.
6. Select true statements concerning the procedure for handling return goods.
7. Select true statements concerning special precautions in handling return goods.
8. Select true statements concerning vehicle use, maintenance, and safety.
9. Select true statements concerning basic rules for scheduling and service calls.
10. List ways to avoid legal problems with equipment and service.
11. Match other management items with how they contribute to good business management.
12. Select true statements concerning how to handle accounting and money with service customers.
13. State the most important rule of good business management.
14. Complete a return goods tag.

BUSINESS MANAGEMENT
UNIT IV

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information sheet.

III. Discuss unit and specific objectives.

IV. Discuss information sheet.

V. Invite a heating and air conditioning contractor to talk to the class about business management and the elements of it that require special attention.

VI. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Assignment Sheet #1--Complete a Return Goods Tag

   D. Answers to assignment sheet

   E. Test

   F. Answers to test

II. References:

   A. Althouse, Andrew D., and Carl H. Turnquist and Alfred F. Bracciano. *Modern Refrigeration and Air Conditioning.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1975.

   B. Russell, Allen. *Getting Started in Heating and Air Conditioning Service.* Birmingham, MI: Business News Publishing Company, 1974.

   C. Taylor, Mark. *Residential Wiring.* Stillwater, OK 74074: The Mid-America Vocational Curriculum Consortium, 1978.

BUSINESS MANAGEMENT
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Business management--The ordered activities of accounting, scheduling, inventory control, and personnel supervision that contribute to safe and effective performance, good customer relations, and continued sales and service

   B. Equipment file--A file for retaining records of the type of heating and cooling equipment each customer has

   C. Suspense file--A file used to remind people of important things to do at specific future dates

   D. Warranty--A written statement that a piece of equipment installed to manufacturer's specifications will be guaranteed for a specific length of time

II. Objectives of good business management

   A. To maintain proper records of in-house and mobile inventory

   B. To maintain proper records of installations, service calls, and maintenance calls

   C. To maintain helpful records concerning customer equipment and warranties

   D. To maintain records to assist in follow-up contact with customers who have indicated interest in add-on or new equipment

   E. To promote punctuality and professional performance with careful scheduling

   F. To promote safety on the job and the safe use of company vehicles

   G. To maintain professional standards that will eliminate the prospects of customer complaints or costly legal activity

   H. To maintain records which will assist in evaluating employee performance

III. Guidelines for maintaining inventory control

   A. Inventory forms should be carried in every service vehicle

   B. Service personnel should record parts and materials used on every job, and submit a complete inventory report at least once a week

INFORMATION SHEET

C. Service personnel should include in the inventory report a list of tools or equipment lost or damaged or any equipment that needs repair

IV. Guidelines for maintaining records of installations, service calls, and maintenance calls

A. All installations should be recorded on a form suitable for filing and include:

1. Customer's name and address
2. Date of installation
3. Company job number
4. All technical information concerning basic equipment and system design, including sizes of belts and filters
5. All equipment or component warranties
6. A signed statement from the installation supervisor that the customer has been instructed in correct operation and maintenance of the system

B. All service calls should be recorded on a form suitable for filing and include:

1. Customer's name and address
2. Date of service call
3. Company job number
4. Nature of the problem
5. How the problem was corrected and the parts or materials used to repair or replace equipment
6. Who made the service call and how long it took
7. A record of the expense to the customer, broken down to show cost of individual items and labor charges
8. All information available concerning type of equipment, its approximate age, and any discussions service personnel had with the customer concerning add-on or replacement equipment

C. All maintenance calls should be recorded on a form suitable for filing and include:

1. Customer's name and address
2. Date of maintenance call
3. Company job number

INFORMATION SHEET

4. Name of person making the call

5. List of all charges to the customer

V. Ways to gather information for a good equipment file

A. Encourage service personnel to observe basic equipment and system design on each call

B. Have service personnel record type of equipment, Btuh ratings, and approximate age of equipment

C. Have service personnel report any information the customer volunteers concerning problems with equipment

D. Have service personnel report any conversations where customers showed an interest in add-on or new equipment

E. List any unusual belt or filter sizes so that on future service calls, the service truck won't have to make an extra trip back to the stockroom for supplies

VI. Procedure for handling return goods

A. Make sure the warranty has not expired

B. Fill out the return goods tag, and be sure it includes:

1. Date and address of installation

2. Date of equipment

3. Time service person spent on replacement

4. Serial number of defective component

5. Brief statement of reasons for failure

6. Any information which would assist the manufacturer in checking the malfunction

C. Separate the dealer and manufacturer tags from the return tag and turn the dealer and manufacturer tags into the office

D. Attach the return tag to the defective component; the tags usually have a wire or a strong cord especially for this purpose, and should be tied securely so they won't come loose in transit

VII. Special precautions in handling return goods

A. Make sure serial numbers of the component are recorded on all three parts of the return tag, the return tag itself, the part for the dealer's files, and the part that goes back to the manufacturer

INFORMATION SHEET

B. Double check the component to be returned to make sure the malfunction is permanent

(NOTE: When a manufacturer finds returned goods are not defective, the company is still charged with the cost.)

C. Read return procedures carefully and make sure return goods are sent to the correct place

(NOTE: To reduce freight costs, many return goods are not sent back to the manufacturers, but to local or area wholesalers who are equipped to spot check the goods for defects.)

D. If there are no written return procedures, call or write the manufacturer for directions

VIII. Vehicle use, maintenance, and safety

A. All vehicles should be safety checked daily, and the check should include:

1. Brakes and brake lights
2. Lights and turning signals
3. Oil and water or antifreeze
4. Tires

B. Start and return mileage should be recorded daily and signed by the operator

C. Maintenance schedules for oil change, tire rotation, tune up, etc. should be left in the glove compartment of each vehicle and checked at least once a week by the operator

D. A city map should be kept in the glove compartment of each vehicle

E. Mobile radio or CB equipment should be checked out daily

F. Vehicles should be washed as needed, waxed, and shined at regular intervals

(NOTE: This is not only a part of vehicle maintenance, it's a part of company image maintenance.)

IX. Basic rules for scheduling and service calls

A. All service personnel should know the day before where their first call will be the next morning and any other than normal parts or materials they need to take with them

INFORMATION SHEET

B. All service personnel should know the addresses of additional calls they are expected to make that day, and should inform the office immediately of any situation that creates a need for rescheduling

C. Service personnel going directly to a job site rather than the shop at the beginning of the work day should inform the shop of their arrival at the job site

D. In situations where a house has to be unlocked by an occupant who is at work, or by a neighbor, the office should contact the party and inform them what time the service person will arrive

E. In situations where a customer cannot be home while service work is being performed, the service person should call the customer on arrival to confirm the nature of the trouble, and inform the customer when the work is completed and what was done

F. Make certain the customer gives advance approval of any unexpected increase in costs, especially if the customer has been given an estimate of repair costs, and especially if the cost increase will be considerable

G. Curious children are intrigued with tools and equipment, and parents should be asked politely, in the interest of safety, to keep children away from the work area

X. Ways to avoid legal problems with equipment and service

A. Use equipment that is listed by a national testing company

(NOTE: Underwriter's Laboratories is a typical national testing company; when a piece of equipment is UL approved, it means it is backed by engineering experts and legal counsel; use of unlisted components or materials is not recommended.)

B. Install all wiring to code and customer specifications

C. Install all equipment according to manufacturer's specifications

(NOTE: An incorrect installation could void equipment listing, warranty, and create legal problems.)

D. Never bypass or jump a part

(NOTE: Bypasses such as copper links for fuses can easily be spotted even after a bad fire.)

E. Replace all covers and secure them well

(NOTE: Loose covers invite the attention of children and also permit dust and dirt to settle on components.)

INFORMATION SHEET

XI. Other management items and how they contribute to good business management

A. Daily reports--These record the daily activity of individual service people, assist with scheduling by recording who does what kind of job best, and provide a basis for evaluating employee performance

B. Suspense file--Should remind you to make 30, 60, and 90-day phone checks with customers who have new installations, can help to remind a customer that a warranty period is about to expire, and can be used for follow-up contact with service customers who have asked about add-on or new equipment

C. Job orders--These provide service people with information concerning customer's name, address, nature of the complaint, the time the customer expects the service call to be made, and assigns a job number for the purposes of bookkeeping and accounting

XII. How to handle accounting and money with service customers

A. The customer's bill should present an itemized accounting of every replacement part used and the amount charged for labor

B. Whether paid by cash or check, the customer should be presented a properly dated receipt, and the customer's check number should be indicated on the receipt

C. Cash or checks should be turned in to the main office at the end of each day along with the copy of the customer's receipt and the job number so accounting can properly credit the customer for payment

D. Customers who intend to finance repairs should make such arrangements in advance with the main office

XIII. The most important rule of good business management--Put it in writing!

BUSINESS MANAGEMENT
UNIT IV

ASSIGNMENT SHEET #1--COMPLETE A RETURN GOODS TAG

Background information:

As a service technician for All Seasons Service Company of 400 West 6th Street in Marshall, Kansas, you are sent to service an inoperative heat pump at the residence of David A. Jones of 304 S. Berry in the same city. Mr. Jones complains that his heat pump, installed less than a year and a half ago, has quit working.

A quick check of the system indicates a compressor burnout. A thorough examination of the compressor indicates the motor windings are slightly burned, and the oil in the unit is very dirty and has a strong smell. You ARE CERTAIN the compressor has suffered a severe burnout and will have to be replaced.

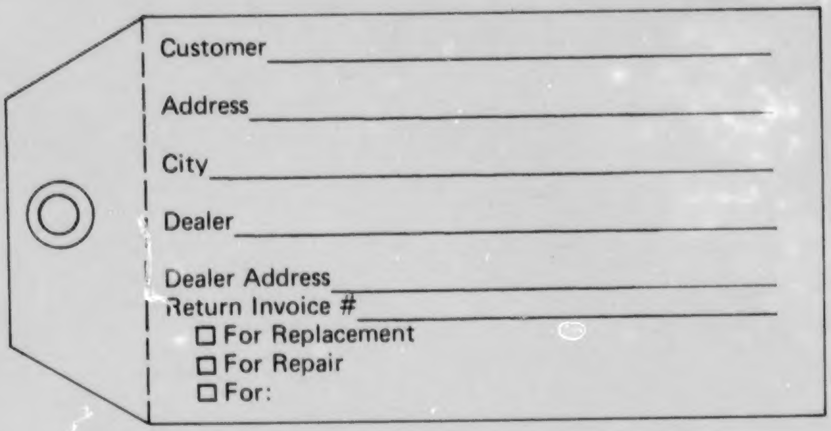
To save time, you call the shop to make sure the burned out compressor is still under warranty, and to have someone deliver a replacement compressor while you remove the bad one. The clerk informs you that the compressor is part of a complete heat pump system which was installed for David Jones on June 3, 1979, and that the compressor is still under warranty. Then, the clerk wants to know the model and serial numbers from the burned out compressor, so you keep him waiting on the phone while you go back to the compressor to find it is a model M-6A with a serial number of M-6A1787. The clerk congratulates you for not getting the information when you first determined the compressor was burned out, and for taking up his time on the phone.

You remove the old compressor while the new one is being delivered from the shop, complete the replacement relatively quickly, and Mr. Jones is pleased his heat pump is working again. Then, Mr. Jones wants to know if the replacement compressor has the same five-year warranty as the original. Since you are not sure, you call the shop and the clerk tells you that replacement equipment normally has only a one year warranty, and reminds you to note the model and serial numbers of the replacement compressor so the new warranty can be mailed to Mr. Jones. The clerk again thanks you for taking up his time on the phone.

At the end of the day, you return to the shop, complete your Job Ticket #B-128, dated August 4, 1980, sign it, and place it in the bookkeeper's "In" basket.

Directions: From the background information given above, complete the return goods tag in Figure 1 and answer the questions that follow (refer to items VI and VII in the Information Sheet before starting.)

ASSIGNMENT SHEET #1



Customer ______________________

Address ______________________

City ______________________

Dealer ______________________

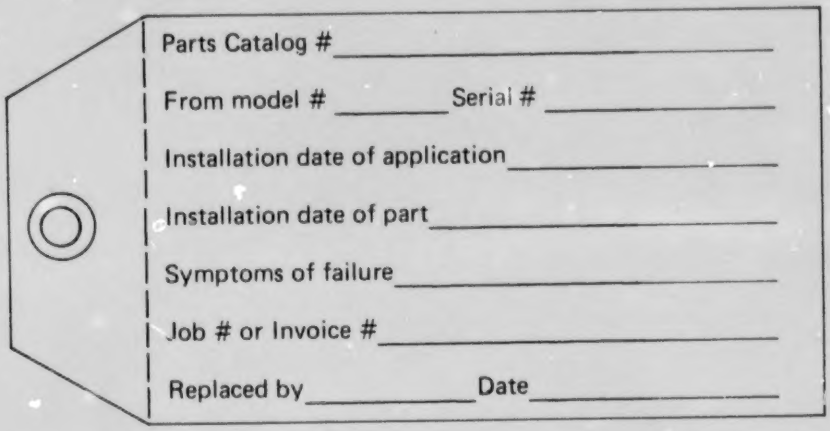
Dealer Address ______________________

Return Invoice # ______________________

☐ For Replacement

☐ For Repair

☐ For:



Parts Catalog # ______________________

From model # __________ Serial # __________

Installation date of application ______________________

Installation date of part ______________________

Symptoms of failure ______________________

Job # or Invoice # ______________________

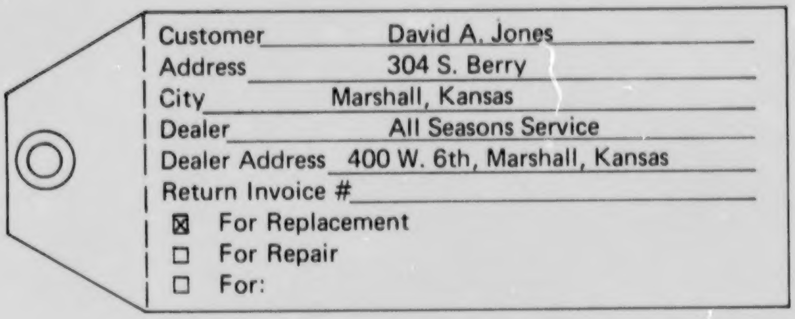
Replaced by __________ Date __________

Questions:

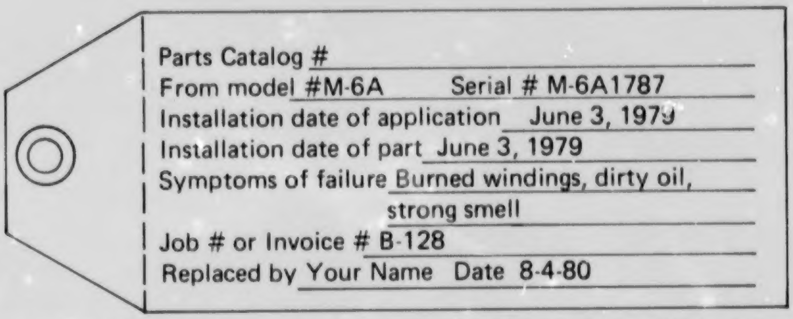
1. As you begin to fill out the return goods tag, you realize that everyone in the shop has left and you don't know what the return invoice number is. What would you do?
2. As you continue filling out the return goods tag, you realize you don't have a parts catalog number. What would you do?
3. As you finish filling in the return goods tag, you realize there is no separate dealer's tag to tear off and leave with the shop. What would you do?
4. What business management rule applies to all of the above questions?

BUSINESS MANAGEMENT
UNIT IV

ANSWERS TO ASSIGNMENT SHEET #1



Customer David A. Jones
Address 304 S. Berry
City Marshall, Kansas
Dealer All Seasons Service
Dealer Address 400 W. 6th, Marshall, Kansas
Return Invoice #
☒ For Replacement
☐ For Repair
☐ For:



Parts Catalog #
From model #M-6A Serial # M-6A1787
Installation date of application June 3, 1979
Installation date of part June 3, 1979
Symptoms of failure Burned windings, dirty oil, strong smell
Job # or Invoice # B-128
Replaced by Your Name Date 8-4-80

1. Put in writing that you need a return invoice number, what you need it for, and leave the note on the desk of someone who can get it for you
2. Put in writing that you need a parts catalog number, what you need it for, and leave a note on the desk of someone who can get it for you
3. Put in writing that you need a copy of the complete return goods tag, and leave the note on the desk of someone who can get it copied for you
4. Put it in writing

BUSINESS MANAGEMENT
UNIT IV

NAME______________________

TEST

1. Match the terms on the right with their correct definitions.

_____a. The ordered activities of accounting, scheduling, inventory control, and personnel supervision that contribute to safe and effective performance, good customer relations, and continued sales and service

_____b. A file for retaining records of the type of heating and cooling equipment each customer has

_____c. A file used to remind people of important things to do at specific future dates

_____d. A written statement that a piece of equipment installed to manufacturer's specifications will be guaranteed for a specific length of time

1. Equipment file
2. Warranty
3. Suspense file
4. Business management

2. List six objectives of good business management.

a.

b.

c.

d.

e.

f.

3. Select true statements concerning guidelines for maintaining inventory control by placing an "X" in the appropriate blank.

_____a. Inventory forms should be carried in every service vehicle

_____b. Service personnel should record parts and materials used on every job, and submit a complete inventory report at least once a month

_____c. Service personnel should include in the inventory report a list of tools or equipment lost or damaged or any equipment that needs repair

4. Select true statements concerning guidelines for maintaining records of installations, service calls, and maintenance calls by placing an "X" in the appropriate blanks.

(NOTE: To be a true statement, all parts of the statement must be true.)

_____a. All installations should be recorded on a form suitable for filing and include:

1) Customer's name and address
2) Date of installation
3) Company job number
4) All technical information concerning basic equipment and system design, including sizes of belts and filters
5) All equipment or component warranties
6) A signed statement from the installation supervisor that the customer has been instructed in correct operation and maintenance of the system

_____b. All service calls should be recorded on a form suitable for filing and include:

1) Customer's name and address
2) Date of service call
3) Company job number
4) Nature of the problem
5) How the problem was corrected and the parts or materials used to repair or replace equipment
6) Who made the service call and how long it took
7) A record of the expense to the customer, broken down to show cost of individual items and labor charges
8) All information available concerning type of equipment, its approximate age, and any discussions service personnel had with the customer concerning add-on or replacement equipment

_____c. All maintenance calls should be recorded on a form suitable for filing and include:

1) Customer's name and address
2) Date of maintenance call
3) Company job number
4) Name of person making the call
5) List of all charges to the customer

5. List four ways to gather information for a good equipment file.

   a.

   b.

   c.

   d.

6. Select true statements concerning the procedure for handl[illegible]eturn goods by placing an "X" in the appropriate blanks.

   _____a. Make sure the warranty is no more than 30 days out of date

   _____b. Fill out the return goods tag, and be sure it includes:

   1) Date and address of installation
   2) Date of equipment
   3) Time service person spent on replacement
   4) Serial number of defective component
   5) Brief statement of reasons for failure
   6) Any information which would assist the manufacturer in checking the malfunction

   _____c. Separate the dealer and manufacturer tags from the return tag and turn the dealer and manufacturer tags into the office

   _____d. Attach the return tag to the defective component; the tags usually have a wire or a strong cord especially for this purpose, and should be tied securely so they won't come loose in transit

7. Select true statements concerning special precautions in handling return goods by placing an "X" in the appropriate blanks.

   _____a. Make sure serial numbers of the component are recorded on all three parts of the return tag, the return tag itself, the part for the dealer's files, and the part that goes back to the manufacturer

   _____b. Double check the component to be returned to make sure the malfunction is permanent

   _____c. Read return procedures carefully and make sure return goods are sent only to the manufacturer

   _____d. If there are no written return procedures, do it the way you think best

8. Select true statements concerning vehicle use, maintenance, and safety by placing an "X" in the appropriate blanks.

______a. All vehicles should be safety checked daily, and the check should include:

1) Brakes and brake lights

2) Lights and turning signals

3) Oil and water or antifreeze

4) Tires

______b. Start and return mileage should be recorded daily and signed by the operator

______c. Maintenance schedules for oil change, tire rotation, tune up, etc. are not the concern of the operator

______d. A city map should be kept in the glove compartment of each vehicle

______e. Mobile radio or CB equipment should be checked out daily

______f. Vehicles should be washed monthly, and waxed and shined at least every six months

9. Select true statements concerning basic rules for scheduling and service calls by placing an "X" in the appropriate blanks.

______a. All service personnel should know the day before where their first call will be the next morning and any other than normal parts or materials they need to take with them

______b. All service personnel should know the addresses of additional calls they are expected to make that day, and should inform the office immediately of any situation that creates a need for rescheduling

______c. Service personnel going directly to a job site rather than the shop at the beginning of the work day should inform the shop of their arrival at the job site

______d. In situations where a house has to be unlocked by an occupant who is at work, or by a neighbor, the office should contact the party and inform them what time the service person will arrive

______e. In situations where a customer cannot be home while service work is being performed, the service person should check with the office

______f. Make certain the customer gives advance approval of any unexpected increase in costs, especially if the customer has been given an estimate of repair costs, and especially if the cost increase will be considerable

______g. Curious children are intrigued with tools and equipment, and parents should be asked politely in the interest of safety, to keep children away from the work area

10. List four ways to avoid legal problems with equipment and service.

    a.

    b.

    c.

    d.

11. Match other management items on the right with the statements that define their contribution to good business management.

    ______ a. These record the daily activity of individual service people, assist with scheduling by recording who does what kind of job best, and provide a basis for evaluating employee performance

    ______ b. Should remind you to make 30, 60, and 90-day phone checks with customers who have new installations, can help to remind a customer that a warranty period is about to expire, and can be used for follow-up contact with service customers who have asked about add-on or new equipment

    ______ c. These provide service people with information concerning customer's name, address, nature of the complaint, and the time the customer expects the service call to be made, and assigns a job number for the purposes of bookkeeping and accounting

    1. Suspense file
    2. Daily reports
    3. Job orders

12. Select true statements concerning how to handle accounting and money with service customers by placing an "X" in the appropriate blanks.

    ______ a. The customer's bill should present an itemized accounting of every replacement part used and the amount charged for labor

    ______ b. Whether paid by cash or check, the customer should be presented a properly dated receipt, and the customer's check number should be indicated on the receipt

    ______ c. Cash or checks should be turned in to the main office at the end of each day along with the copy of the customer's receipt and the job number so accounting can properly credit the customer for payment

    ______ d. Customers who intend to finance repairs should make such arrangements after the work is done and they know what the exact cost will be

13. State the most important rule of good business management.

14. Complete a return goods tag.

(NOTE: If item 14 has not been accomplished prior to the test, ask your instructor when it should be completed.)

BUSINESS MANAGEMENT
UNIT IV

ANSWERS TO TEST

1. a. 4
   b. 1
   c. 3
   d. 2

2. Any six of the following:

   a. To maintain proper records of in-house and mobile inventory

   b. To maintain proper records of installations, service calls, and maintenance calls

   c. To maintain helpful records concerning customer equipment and warranties

   d. To maintain records to assist in follow-up contact with customers who have indicated interest in add-on or new equipment

   e. To promote punctuality and professional performance with careful scheduling

   f. To promote safety on the job and the safe use of company vehicles

   g. To maintain professional standards that will eliminate the prospects of customer complaints or costly legal activity

   h. To maintain records which will assist in evaluating employee performance

3. a, c

4. a, b, c

5. Any four of the following:

   a. Encourage service personnel to observe basic equipment and system design on each call

   b. Have service personnel record type of equipment, Btuh ratings, and approximate age of equipment

   c. Have service personnel report any information the customer volunteers concerning problems with equipment

   d. Have service personnel report any conversations where customers showed an interest in add-on or new equipment

   e. List any unusual belt or filter sizes so that on future service calls, the service truck won't have to make an extra trip back to the stockroom for supplies

6. b, c, d

7. a, b

8. a, b, d, e

9. a, b, c, d, f, g

10. Any four of the following:

    a. Use equipment that is listed by a national testing company

    b. Install all wiring to code and customer specifications

    c. Install all equipment according to manufacturer's specifications

    d. Never bypass or jump a part

    e. Replace all covers and secure them well

11. a. 2
    b. 1
    c. 3

12. a, b, c

13. Put it in writing

14. Evaluated to the satisfaction of the instructor

PSYCHROMETRICS
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to show the location of basic elements on a psychrometric chart and correctly operate a sling psychrometer. The student should also be able to plot unknown psychrometric relationships from two known factors. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to psychrometrics with their correct definitions.
2. List basic information found on a psychrometric chart.
3. Complete a psychrometric chart showing the location of dry-bulb temperature readings.
4. Complete a psychrometric chart showing the location of wet-bulb temperature readings.
5. Complete a psychrometric chart showing the location of dew point temperature readings.
6. Complete a psychrometric chart showing the location of relative humidity readings.
7. List three basic cumulative psychrometric processes.
8. Select true statements concerning typical air-conditioning processes that can be shown on a psychrometric chart.
9. Identify the components of a sling psychrometer.
10. Arrange in order the steps in operating a sling psychrometer.
11. Demonstrate the ability to:
    a. Determine relative humidity when only dry-bulb and wet-bulb temperatures are known.
    b. Determine dew point when only dry-bulb and wet-bulb termperatures are known.
    c. Determine how outside air should be conditioned to provide a comfortable humidity and temperature combination in winter heating.

d. Determine how outside air should be conditioned to provide a comfortable humidity and temperature combination in summer cooling.

e. Determine the relative humidity of a conditioned space.

f. Determine the relative humidity of an outdoor space.

g. Determine the wet-bulb temperature of the air inside a duct.

PSYCHROMETRICS
UNIT V

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information, assignment, and job sheets.

III. Make transparency.

IV. Discuss unit and specific objectives.

V. Discuss information, assignment, and job sheets.

VI. Have a sling psychrometer or an aspirating psychrometer available to demonstrate to the class how accurate wet-bulb temperature readings are taken.

VII. Prepare a psychrometric chart and demonstrate to the class the air-conditioning processes that can be shown on a psychrometric chart in reference to item VIII in the information sheet.

VIII. Invite a representative of a local air conditioning company to speak to the class concerning the contribution psychrometric plotting makes to the endeavor of load calculation and equipment selection.

IX. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency Master 1--Psychrometric Chart
- D. Assignment sheets
    1. Assignment Sheet #1--Determine Relative Humidity When Only Dry-Bulb and Wet-Bulb Temperatures are Known
    2. Assignment Sheet #2--Determine Dew Point When Only Dry-Bulb and Wet-Bulb Temperatures are Known
    3. Assignment Sheet #3--Determine How Outside Air Should be Conditioned to Provide a Comfortable Humidity and Temperature Combination in Winter Heating
    4. Assignment Sheet #4--Determine How Outside Air Should be Conditioned to Provide a Comfortable Humidity and Temperature Combination in Summer Cooling

E. Answers to assignment sheets

F. Job sheets

1. Job Sheet #1–Determine the Relative Humidity of a Conditioned Space

2. Job Sheet #2–Determine the Relative Humidity of an Outdoor Space

3. Job Sheet #3–Determine the Wet-Bulb Temperature of the Air Inside a Duct

G. Test

H. Answers to test

II. References:

A. Carrier Air Conditioning Company. *Handbook of Air Conditioning System Design.* New York, NY: McGraw-Hill, Inc., 1965.

B. Lang, Paul V. *Principles of Air Conditioning.* Albany, NY 12205: Delmar Publishers/Litton Educational Publishing, Inc., 1972.

C. Althouse, Andrew D., and Carl H. Turnquist and Alfred F.Bracciano. *Modern Refrigeration and Air Conditioning.* South Holland, IL 60473: The Goodheart-Willcox Company, Inc., 1975.

PSYCHROMETRICS
UNIT V

INFORMATION SHEET

I. Terms and definitions

   A. Psychometrics--The science of measuring and changing the properties of air

   B. Dry-bulb temperature--The air temperature as measured by an ordinary thermometer

   C. Wet-bulb temperature--The air temperature as measured by a thermometer whose bulb is covered with a wet cloth or wet wick and moved in air that has a velocity of one thousand feet per minute

   D. Relative humidity--The percentage of moisture in the air compared to the total amount of moisture the air could hold at the same temperature and barometric pressure

   E. Dew point--The temperature at which moisture condenses as liquid on a surface

   F. Latent heat--The addition of heat in a situation where moisture content increases but air temperature does not change

   G. Latent cooling--The removal of heat in a situation where moisture content decreases but air temperature does not change

   H. Sensible heat--The addition of heat in a situation where air temperature increases but moisture content does not change

   I. Sensible cooling--The removal of heat in a situation where air temperature decreases but moisture content does not change

   J. Sensible heat factor--The relationship of sensible heat to total heat

   K. Enthalpy--The heat in air as measured in Btu's per pound of dry air

II. Basic information found on a psychrometric chart (Transparency 1)

   A. Dry-bulb temperature

   B. Wet-bulb temperature

   C. Dew point temperature

   D. Relative humidity

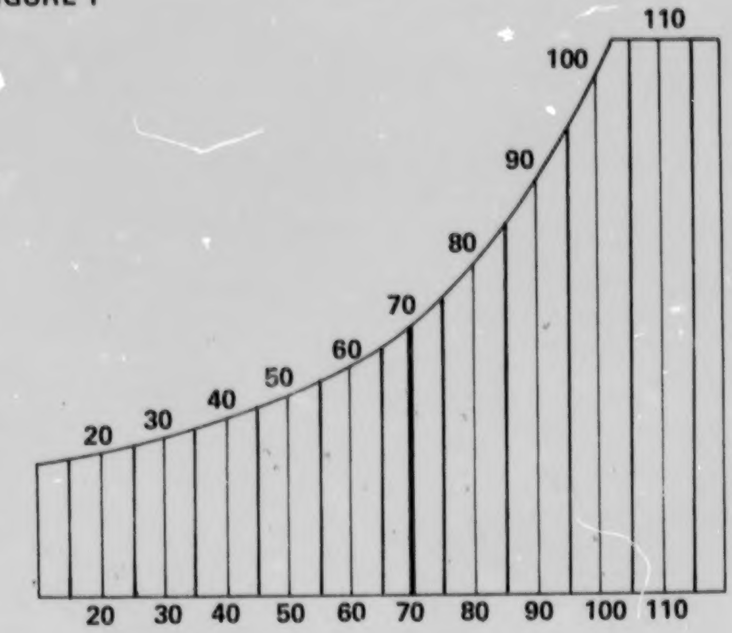
INFORMATION SHEET

III. Reading dry-bulb temperature on a psychrometric chart (Figure 1)

A. The degree reading is represented by a vertical line

B. Degree readings advance from left to right in units of 5 degrees on a straight horizontal line at the bottom of the chart

FIGURE 1



Dry-Bulb Lines

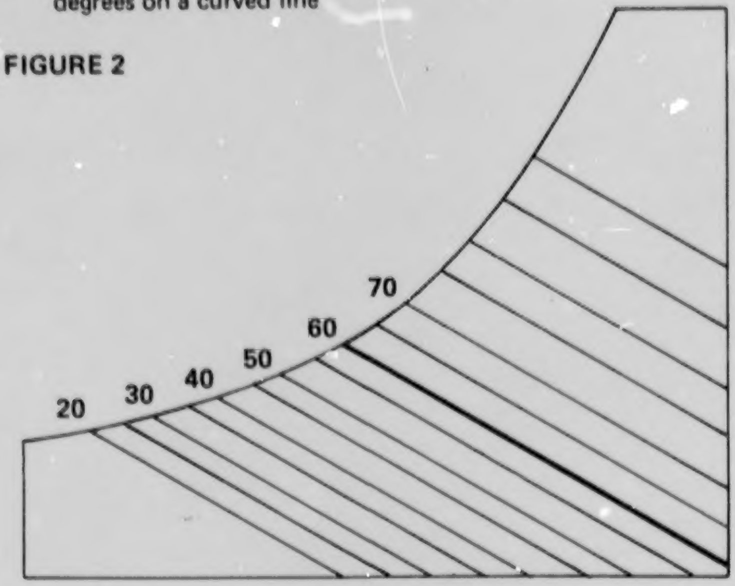
IV. Reading wet-bulb temperature on a psychrometric chart (Figure 2)

A. The degree reading is represented by a diagonal line

INFORMATION SHEET

B. Degree readings advance from lower left to upper middle in units of 5 degrees on a curved line

FIGURE 2



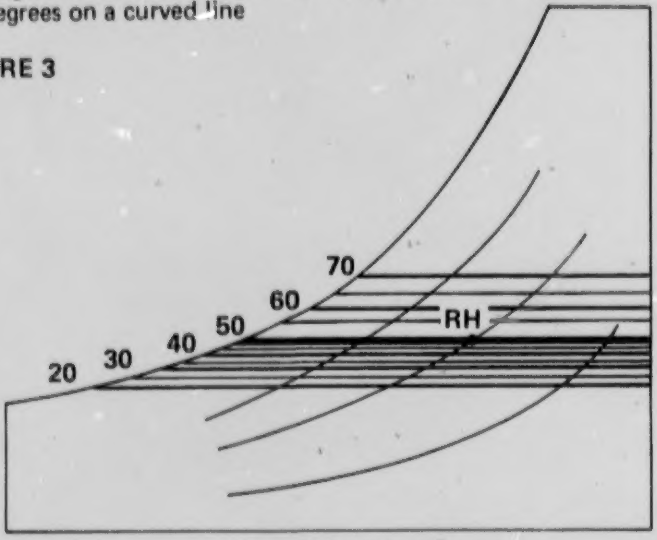
Wet-Bulb Lines

V. Reading dew point on a psychrometric chart (Figure 3)

A. The degree reading is represented by a horizontal line

B. Degree readings advance from lower left to upper middle in units of 5 degrees on a curved line

FIGURE 3



Dew Point Lines

INFORMATION SHEET

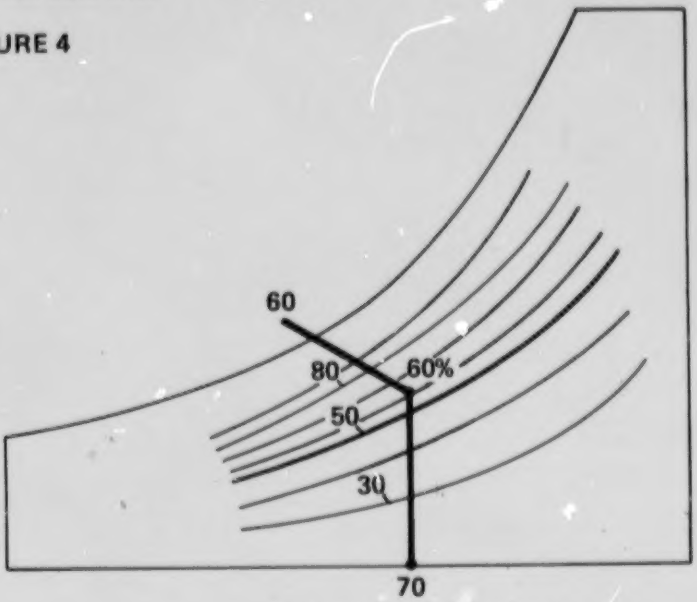
VI. Reading relative humidity on a psychrometric chart (Figure 4)

A. Percentages are expressed in units of ten ranging from 0 to 100

B. Percentage readings advance from bottom left to lower and upper right on curved lines

C. Relative humidity is read at the point of intersection of the dry-bulb and wet-bulb lines

FIGURE 4



Relative Humidity Lines

VII. Basic cumulative psychrometric processes

A. Cooling and humidifying

B. Cooling and dehumidifying

C. Heating and humidifying

VIII. Typical air-conditioning processes that can be shown on a psychrometric chart

A. That outdoor air adds heat and moisture when it is mixed with indoor air

B. That heat and moisture are removed as they pass through the air-conditioning apparatus

C. That an air mixture of correct temperature and humidity can be determined to maintain a comfort zone in a given area

INFORMATION SHEET

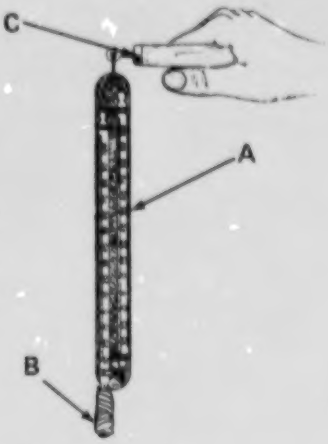
IX. Components of a sling psychrometer (Figure 5)

A. Standard thermometer

B. Wet wick mounted on a standard thermometer

C. Holding device attached to a handle in such a way the thermometer can be whirled in the air

FIGURE 5



X. Steps in operating a sling psychrometer

A. Saturate the wet wick with distilled water

(NOTE: Clean, white cotton makes the best wick, and using distilled water helps avoid lime deposits on the wick.)

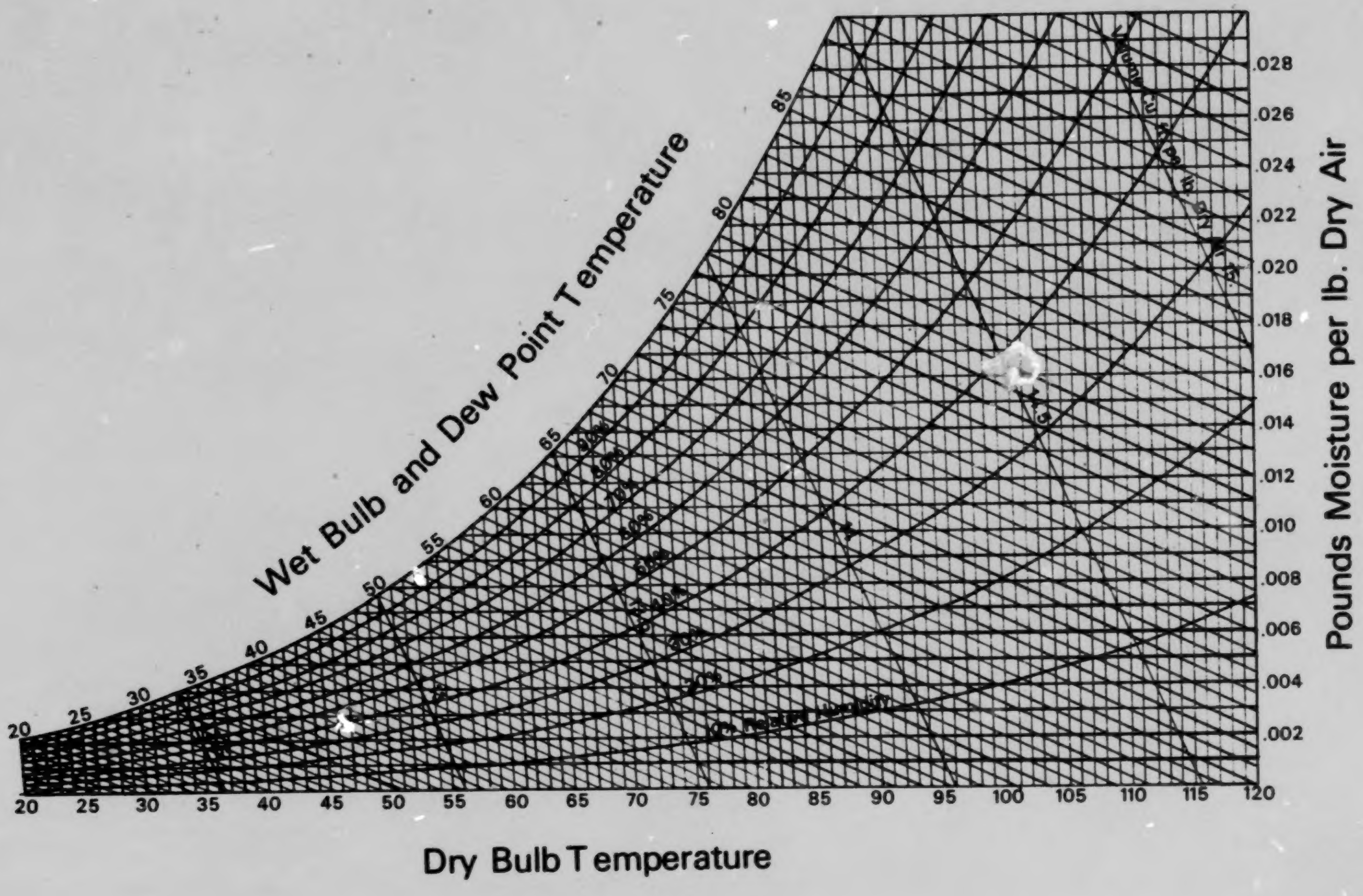
B. Whirl the psychrometer rapidly in the air for about 30 seconds and take a reading

C. Whirl the psychrometer rapidly a second time for about 15 to 30 seconds and take a final reading

D. Record both dry- and wet-bulb temperatures on a psychrometric chart

(NOTE: The difference between wet and dry bulb temperature readings is "wet bulb depression," but the basic readings are all that are needed to begin psychrometric plotting.)

Psychrometric Chart



PSYCHROMETRICS
UNIT V

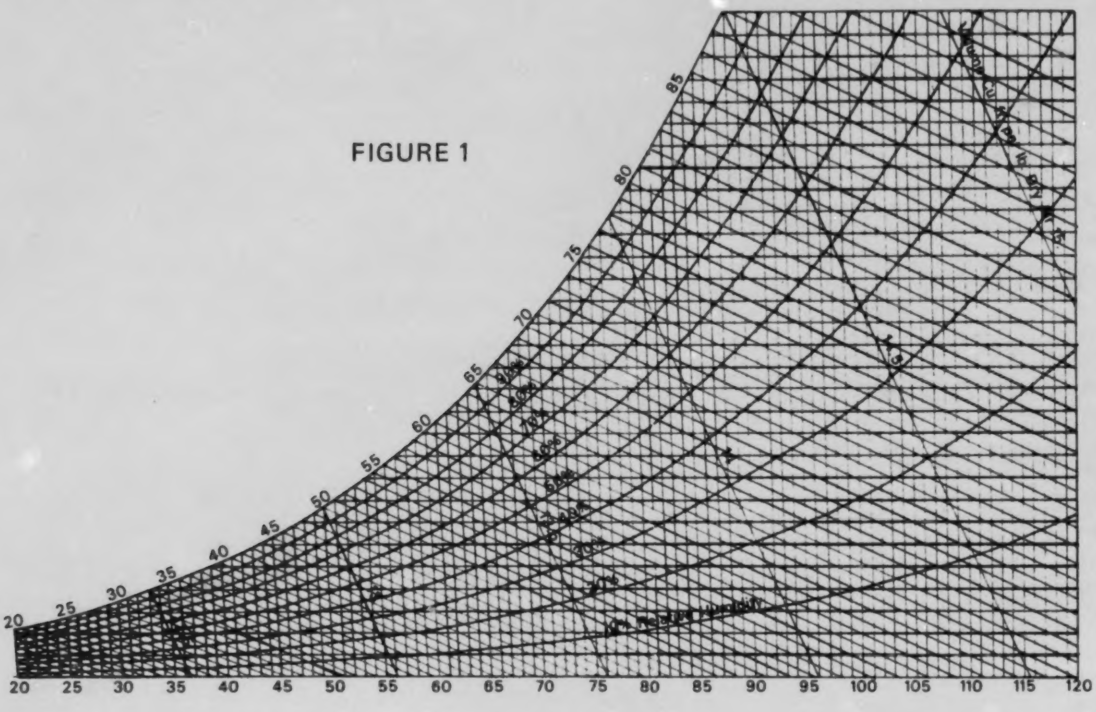
ASSIGNMENT SHEET #1--DETERMINE RELATIVE HUMIDITY WHEN ONLY DRY-BULB AND WET-BULB TEMPERATURES ARE KNOWN

Directions: Complete the psychrometric chart in Figure 1 by plotting the correct lines to determine relative humidity

Procedure:

1. Draw a vertical line up the chart from the point on the dry-bulb temperature scale that reads 72°F
2. Draw a diagonal line down the chart from the point on the wet-bulb temperature scale that reads 54°F until it intersects the dry-bulb temperature line
3. The relative humidity is determined by the point where the lines of dry-bulb and wet-bulb temperatures intersect, and this gives a relative humidity reading of approximately ______ percent

FIGURE 1



PSYCHROMETRICS
UNIT V

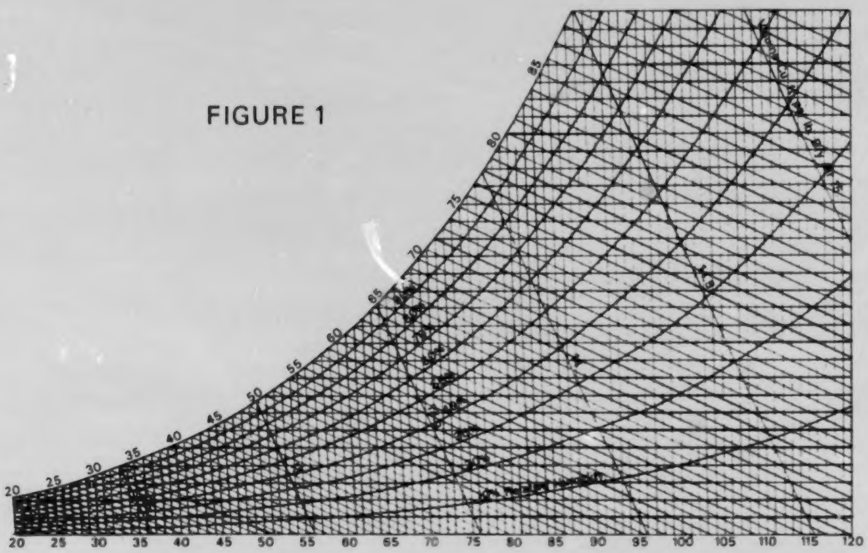
ASSIGNMENT SHEET #2--DETERMINE DEW POINT WHEN ONLY DRY-BULB AND WET-BULB TEMPERATURES ARE KNOWN

Directions: Complete the psychrometric chart in Figure 1 by plotting the correct lines to determine dew point

Procedure:

1. Draw a vertical line up the chart from the point where the dry-bulb temperature reads 75°F
2. Draw a diagonal line down the chart from the point where the wet-bulb temperature reads 60°F until it intersects the line drawn in item 1
3. From the point where the two lines in item 2 intersect, draw a horizontal line to the left of the chart
4. Where the line in item 3 intersects the dew point scale the reading is ________________

FIGURE 1



PSYCHROMETRICS
UNIT V

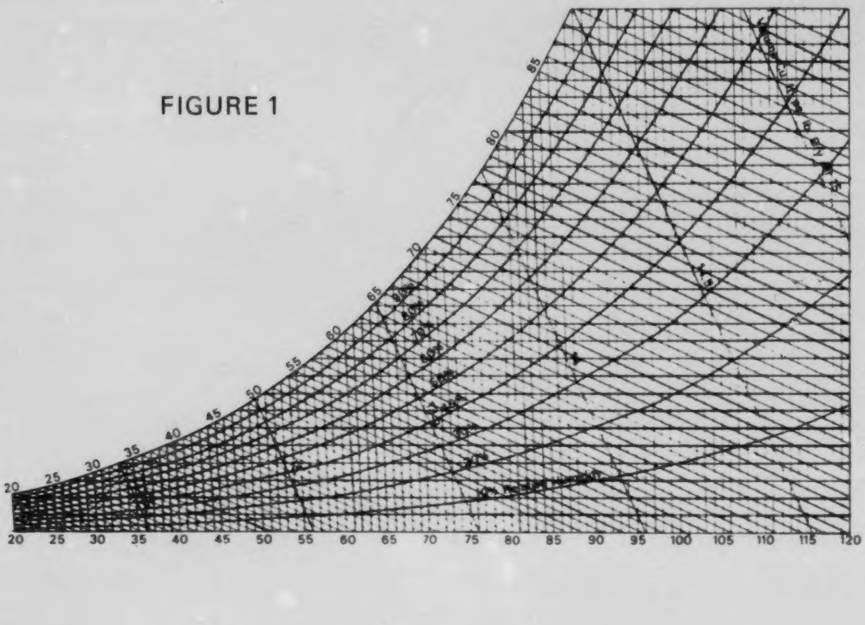
ASSIGNMENT SHEET #3--DETERMINE HOW OUTSIDE AIR SHOULD BE CONDITIONED TO PROVIDE A COMFORTABLE HUMIDITY AND TEMPERATURE COMBINATION IN WINTER HEATING

Directions: Assume that a winter heating situation is present with an outdoor dry-bulb temperature of 35°F and outdoor relative humidity of 25%, and that the indoor comfort conditions should be within the range of 30 to 35% relative humidity and a temperature range of 72 to 75°F.

Procedure:

1. On the psychrometric chart in Figure 1, place a mark where the 35°F dry-bulb temperature and a relative humidity of 25% intersect
2. Place a mark where the 75°F dry-bulb temperature and a relative humidity of 35% intersect
3. Draw a line between the marks made in items 1 and 2
4. Relative humidity (increases) (decreases) and moisture must be (added to) (removed from) the air
5. Dry-bulb temperature (increases) (decreases) and heat must be (added to) (removed from) the air

FIGURE 1



PSYCHROMETRICS
UNIT V

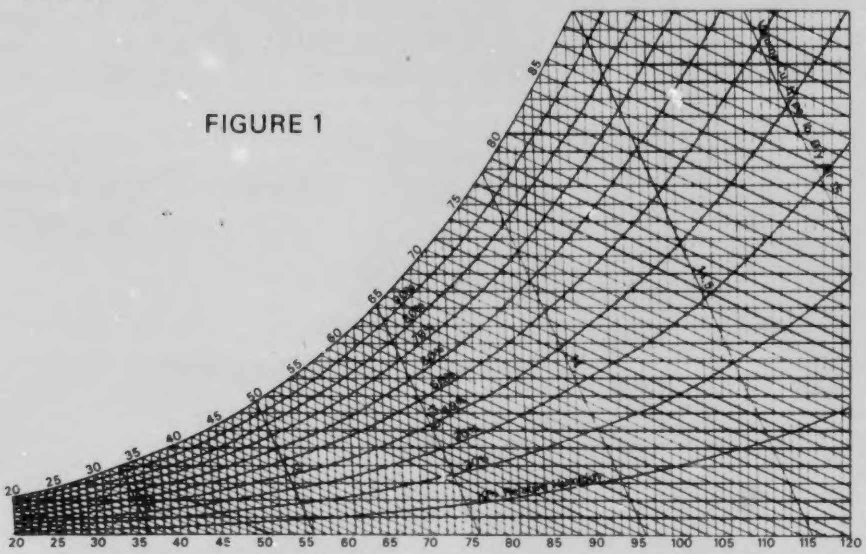
ASSIGNMENT SHEET #4--DETERMINE HOW OUTSIDE AIR SHOULD BE CONDITIONED TO PROVIDE A COMFORTABLE HUMIDITY AND TEMPERATURE COMBINATION IN SUMMER COOLING

Directions: Assume that a summer air conditioning situation is present with an outdoor dry-bulb temperature of 90°F and an outdoor relative humidity of 70%, and that the indoor comfort conditions should be within the range of 45 to 50% relative humidity and a temperature range of 75 to 78°F

Procedure:

1. On the psychrometric chart in Figure 1, place a mark where the 90°F dry-bulb temperature and a relative humidity of 70% intersect
2. Place a mark where the 78°F dry-bulb temperature and a relative humidity of 50% intersect
3. Draw a line between the marks made in items 1 and 2
4. Relative humidity (increases) (decreases) and moisture must be (added to) (removed from) the air
5. Dry-bulb temperature (increases) (decreases) and heat must be (added to) (removed from) the air

FIGURE 1



PSYCHROMETRICS
UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

3. 30%

Assignment Sheet #2

4. 50°F

Assignment Sheet #3

4. Relative humidity increases and moisture must be added to the air
5. Dry-bulb temperature increases and heat must be added to the air

Assignment Sheet #4

4. Relative humidity decreases and moisture must be removed from the air
5. Dry-bulb temperature decreases and heat must be removed from the air

PSYCHROMETRICS
UNIT V

JOB SHEET #1--DETERMINE THE RELATIVE HUMIDITY OF A CONDITIONED SPACE

I. Tools and equipment

- A. 1 sling psychrometer
- B. 1 psychrometric chart
- C. 1 clean cotton wick
- D. Distilled water
- E. Conditioned space as selected by instructor

II. Procedure

- A. Saturate the wick thoroughly with distilled water
- B. Whirl the psychrometer rapidly in the air for at least 30 seconds and take a reading
- C. Whirl the psychrometer rapidly in the air for another 15 to 30 seconds and take a final reading

  (NOTE: When manufacturer's instructions for psychrometer operation are available, follow them carefully.)
- D. Enter dry-bulb and wet-bulb readings on a psychrometric chart
- E. Record the relative humidity of the conditioned space
- F. Check with your instructor for accuracy of your reading
- G. Clean and return psychrometer to proper storage area

PSYCHROMETRICS
UNIT V

JOB SHEET #2--DETERMINE THE RELATIVE HUMIDITY OF AN OUTDOOR SPACE

I. Tools and equipment

A. 1 sling psychrometer

B. 1 psychrometric chart

C. 1 clean cotton wick

D. Distilled water

E. Outdoor space as selected by instructor

II. Procedure

A. Saturate the wick thoroughly with distilled water

B. Whirl the psychrometer rapidly in the air for at least 30 seconds and take a reading

C. Whirl the psychrometer rapidly in the air for another 15 to 30 seconds and take a final reading

(NOTE: When manufacturer's instructions for psychrometer operation are available, follow them carefully.)

D. Enter dry-bulb and wet-bulb readings on a psychrometric chart

E. Record the relative humidity of the outdoor space

F. Check with your instructor for accuracy of your reading

G. Clean and return psychrometer to proper storage area

PSYCHROMETRICS
UNIT V

JOB SHEET #3--DETERMINE THE WET-BULB TEMPERATURE OF THE AIR INSIDE A DUCT

I. Tools and equipment

  A. 1 sling psychrometer

  B. 1 psychrometric chart

  C. Distilled water

  D. Awl

  E. Left hand aviation snips

  F. Duct tape

  G. Duct as selected by instructor

II. Procedure

  A. Properly prepare psychrometer

  B. Make inital opening in the duct with the awl

  C. Enlarge the opening with aviation snips until it is just large enough to facilitate the psychrometer

  D. Insert the psychrometer carefully

  E. Turn fan on and allow it to run until the wet-bulb reading reaches its maximum depression

  F. Record wet-bulb reading on psychrometric chart

  G. Remove psychrometer and patch opening with duct tape

  H. Check with instructor for accuracy of your reading

  I. Clean psychrometer and return to proper storage area

PSYCHROMETRICS
UNIT V

NAME ______________________

TEST

1. Match the terms on the right with their correct definitons.

______a. The science of measuring and changing the properties of air

______b. The air temperature as measured by an ordinary thermometer

______c. The air temperature as measured by a thermometer whose bulb is covered with a wet cloth or wet wick and moved in air that has a velocity of one thousand feet per minute

______d. The percentage of moisture in the air compared to the total amount of moisture the air could hold at the same temperature and barometric pressure

______e. The temperature at which moisture condenses as liquid on a surface

______f. The addition of heat in a situation where moisture content increases but air temperature does not change

______g. The removal of heat in a situation where moisture content decreases but air temperature does not change

______h. The addition of heat in a situation where air temperature increases but moisture content does not change

______i. The removal of heat in a situation where air temperature decreases but moisture content does not change

______j. The relationship of sensible heat to total heat

______k. The heat in air as measured in Btu's per pound of dry air

1. Dew point
2. Sensible cooling
3. Latent heat
4. Dry-bulb temperature
5. Enthalpy
6. Psychrometrics
7. Latent cooling
8. Relative humidity
9. Sensible heat factor
10. Sensible heat
11. Wet-bulb temperature

2. List four items of basic information found on a psychrometric chart.

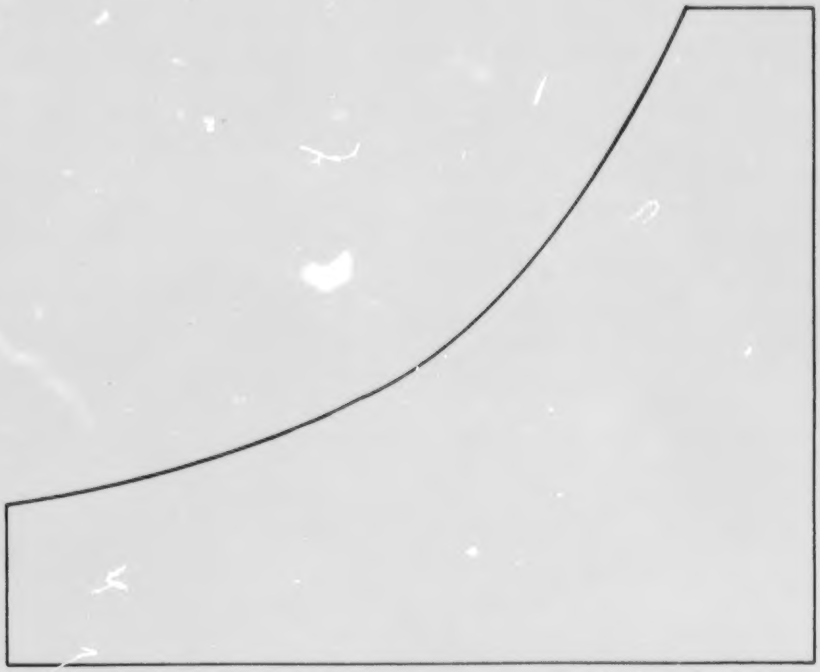
   a.

   b.

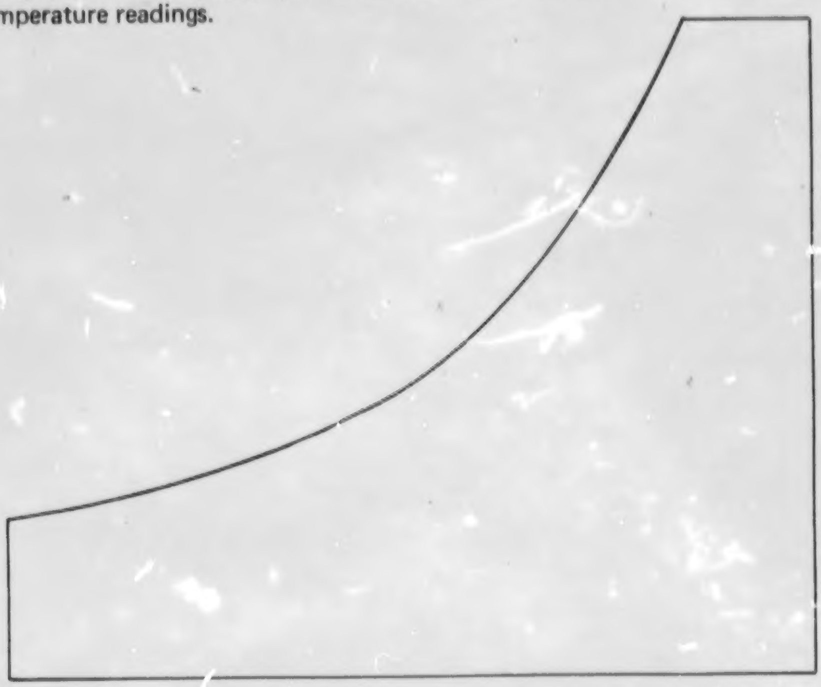
   c.

   d.

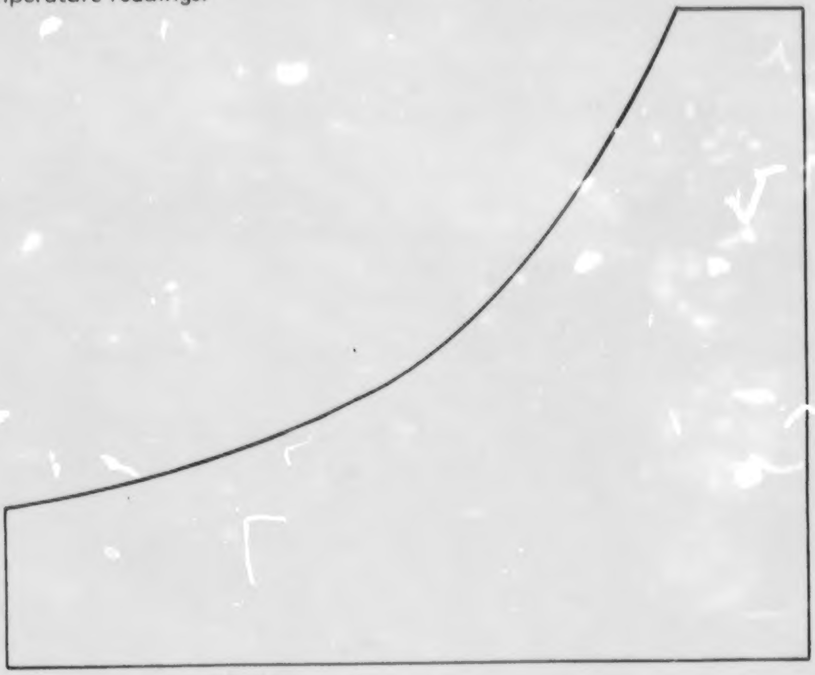
3. Complete the following psychrometric chart to show the location of dry-bulb temperature readings.



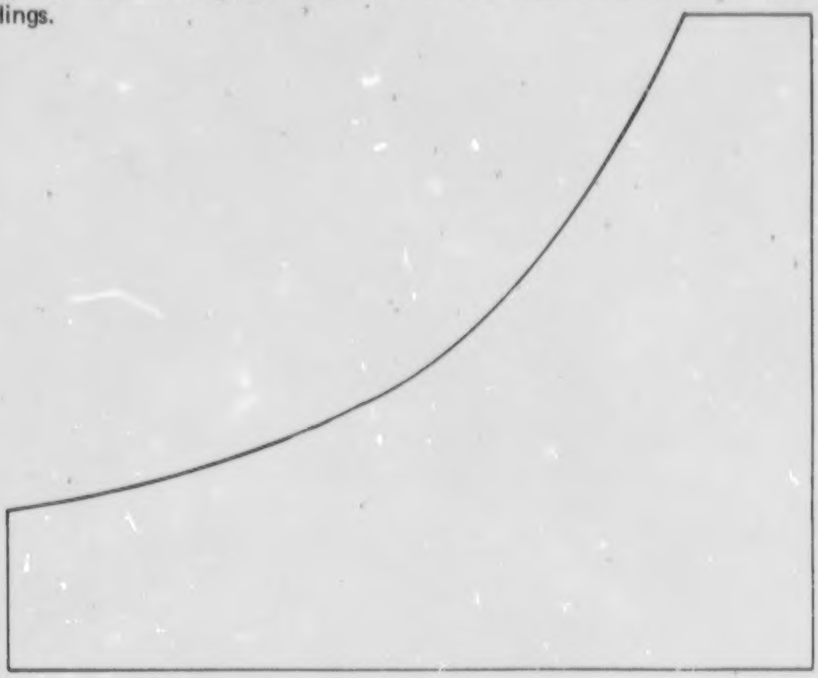
4. Complete the following psychrometric chart to show the location of wet-bulb temperature readings.



5. Complete the following psychrometric chart to show the location of dew point temperature readings.



6. Complete the following psychrometric chart to show the location of relative humidity readings.



7. List three basic cumulative psychrometric processes.

   a.

   b.

   c.

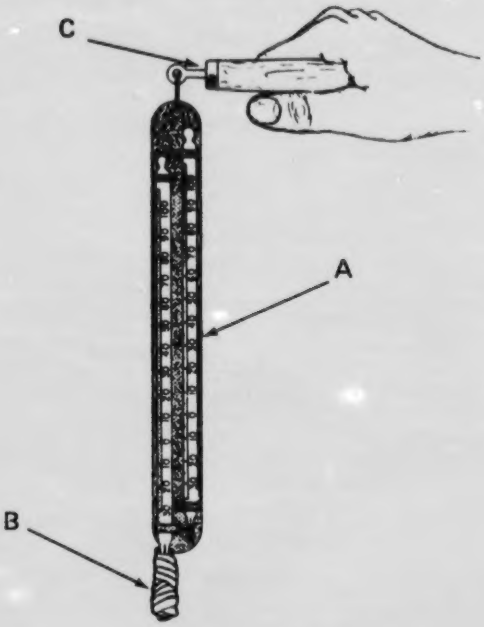
8. Select true statements concerning typical air-conditioning processes that can be on a psychrometric chart by placing an "X" in the appropriate blanks.

   ______a. That outdoor air subtracts heat and moisture when it is mixed v air

   ______b. That heat and moisture are removed as they pass through tioning apparatus

   ______c. That an air mixture of correct temperature and humi mined to maintain a comfort zone in a given area

9. Identify components of a sling psychrometer.



a.________________

b.________________

c.______________________________

10. Arrange in order the steps in operating a sling psychrometer by placing the correct sequence number in the appropriate blank.

______a. Record both dry and wet-bulb temperatures on a psychrometric chart

______b. Whirl the psychrometer rapidly in the air for about 30 seconds and take a reading

______c. Whirl the psychrometer rapidly a second time for about 15 to 30 seconds and take a final reading

______d. Saturate the wet wick with distilled water

11. Demonstrate the ability to:

a. Determine relative humidity when only dry-bulb and wet-bulb temperatures are known.

b. Determine dew point when only dry-bulb and wet-bulb temperatures are known.

c. Determine how outside air should be conditioned to provide a comfortable humidity and temperature combination in winter heating.

d. Determine how outside air should be conditioned to provide a comfortable humidity and temperature combination in summer cooling.

e. Determine the relative humidity of a conditioned space.

f. Determine the relative humidity of an outdoor space.

g. Determine the wet-bulb temperature of the air inside a duct.

(NOTE: If these activities have not been completed prior to the test, ask your instructor when they should be completed.)

PSYCHROMETRICS
UNIT V

ANSWERS TO TEST

1. a. 6
   b. 4
   c. 11
   d. 8
   e. 1
   f. 3
   g. 7
   h. 10
   i. 2
   j. 9
   k. 5

2. a. Dry-bulb temperature
   b. Wet-bulb temperature
   c. Dew point temperature
   d. Relative humidity

3. Chart should show:

   a. The degree reading is represented by a vertical line

   b. Degree readings advance from left to right in units of 5 degrees on a straight horizontal line at the bottom of the chart

4. Chart should show:

   a. The degree reading is represented by a diagonal line

   b. Degree readings advance from lower left to upper middle in units of 5 degrees on a curved line

5. Chart should show:

   a. The degree reading is represented by a horizontal line

   b. Degree readings advance from lower left to upper middle in units of 5 degrees on a curved line

6. Chart should show:

   a. Percentages are expressed in units of ten ranging from 0 to 100

   b. Percentage readings advance from bottom left to lower and upper right on curved lines

   c. Relative humidity is read at the point of intersection of the dry-bulb and wet-bulb lines

7. a. Cooling and humidifying
   b. Cooling and dehumidifying
   c. Heating and humidifying

8. b, c

9. a. Standard thermometer
   b. Wet wick mounted on a standard thermometer
   c. Holding device attached to a handle in such a way the thermometer can be whirled in the air

10. a. 4
    b. 2
    c. 3
    d. 1

11. Evaluated to the satisfaction of the instructor

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to use construction numbers, heat transfer multipliers, and design conditions for estimating heat loss and heat gain and load calculations. The student should also be able to select factors to consider in equipment selection, and use tables and worksheets to estimate heat loss and heat gain for a specific structure in a given geographical location. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to heat loss and heat gain with their definitions.
2. List two reasons why standardized procedures in calculating residential heating and cooling loads are valuable.
3. List factors in determining heat loss and heat gain.
4. Select true statements concerning the steps in calculating heat transfer multipliers.
5. Select true statements concerning factors to consider when sizing heating equipment.
6. Select true statements concerning factors to consider when sizing cooling equipment.
7. List ways structural modifications can affect equipment selection.
8. Demonstrate the ability to:
    a. Estimate heat loss for a temporary residence.
    b. Calculate shaded and unshaded glass areas for use in heat gain estimates.
    c. Estimate heat gain for a temporary residence.
    d. Evaluate the addition of insulation in relation to heat loss and heat gain.

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Discuss unit and specific objectives

IV. Discuss information and assignment sheets.

V. Utilize *Manual J* as a supplement to this unit.

VI. Arrange for each member of the class to have a "Form J-1 Worksheet" to use in completing the assignment sheets with this unit.

(NOTE: Copies of *Manual J* and "Form J-1 Worksheet" are available from The Air-Conditioning Contractors of America, 1228 17th St. N.W., Washington, DC 20036; members of ACCA can buy materials at rates lower than non-members can purhcase them, so a local contractor who is an ACCA member may be willing to assist in obtaining items needed from ACCA.)

VII. Discuss with the class how allowances for various psychrometric processes are calibrated into the tables that appear in *Manual J*.

VIII. Discuss with the class the importance of construction numbers in correctly calculating heat loss and heat gain, and prepare sample components to help illustrate the material in item IV of this unit.

IX. Invite an engineer from a local utility to talk to the class about heat loss and heat gain, how load estimates are made, and how the information is essential to proper equipment selection.

X. Modify the answers to Assignment Sheets #1 through #4 to compensate for proposed changes to *Manual J* as they become available.

XI. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

C. Assignment sheets
   1. Assignment Sheet #1--Estimate Heat Loss for a Temporary Residence
   2. Assignment Sheet #2--Calculate Shaded and Unshaded Glass Areas for Use in Heat Gain Estimates
   3. Assignment Sheet #3--Estimate Heat Gain for a Temporary Residence
   4. Assignment Sheet #4--Evaluate the Addition of Insulation in Relation to Heat Loss and Heat Gain

D. Test

E. Answers to test

II. References:

A. *Manual J, Load Calculation for Residential Winter and Summer Air Conditioning.* Washington, DC 20036: The Air-Conditioning Contractors of America (ACCA), Fifth Edition, First Printing, 1980.

(NOTE: *Manual J* was published originally by The National Environmental Systems Contractors Association (NESCA), an organization now known as the Air-Conditioning Contractors of America (ACCA).)

B. *Manual K, Equipment Selection and System Design Procedures.* Washington, DC 20036: The Air-Conditioning Contractors of American (ACCA), Second Edition, 1975.

(NOTE: This manual was also originally published by NESCA.)

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Btu (British thermal unit)--The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit

B. Btuh (British thermal units per hour)--The unit used to express hourly heat flow

C. Heat transfer--The movement of heat from one substance or region to another

D. HTM (Heat Transfer Multiplier)--An index of heat transfer through one square foot of a structural component at specific design conditions

E. R-value--The rating given to a material's ability to resist heat transfer

F. U-value--One divided by the total R-values of a component

G. Gross exposed walls--The total square footage, including doors and windows, of walls exposed to the outside

H. Net exposed walls--The total square footage, excluding doors and windows, of walls exposed to the outside

I. Exposed partition--A wall separating a conditioned space from an unconditioned space

J. Knee walls--Walls of upper rooms exposed to attic temperatures

K. Internal heat gain--Sensible heat gain produced by people and appliances

L. Duct loss and duct gain--Heating and cooling lost or gained because of air leakage and heat transfer in ducts

M. Ventilation--Controlled air brought into a structure

N. Infiltration--Uncontrolled air that leaks into a structure

O. Cfm--Cubic feet per minute

P. Ton of refrigeration--A refrigerating effect equal to 12,000 Btuh

II. Reasons standardized procedures in calculating residential heating and cooling loads are valuable

A. Charts and tables in most load estimating forms reflect years of cumulative technical information through which the air conditioning industry has improved and simplified the load calculation process

INFORMATION SHEET

B. Residential heating and cooling load estimates can be calculated from technically correct charts and tables that can be easily understood and readily applied

(NOTE: Almost all manufacturers of heating and cooling equipment publish materials for load estimating, but because it reflects a standard in the industry, and because of its acceptance by FHA, *Manual J* and its accompanying "Form J-1 Worksheet," have been selected to supplement the objectives and assignment sheets in this unit of instruction, and items from *Manual J* and the "Form J-1 Worksheet" which appear in this unit are reprinted with permission of the Air-Conditioning Contractors of America.)

III. Factors in determining heat loss and heat gain

A. Size of structure and the insulating qualities of its components

(NOTE: Floor plans and specifications usually provide this information.)

B. Outside design temperature for heat loss

C. Daily temperature range for heat gain

D. Inside design temperature

E. Design temperature difference for heat loss

F. HTM heating or HTM cooling

IV. Steps in calculating heat transfer multipliers

A. Determine the R-value of the construction component

(NOTE: For detailed information concerning calculating heat transfer multipliers, see Appendix A of *Manual J*.)

B. Determine the U-value of the construction component

(NOTE: In cases where a construction component consists of more than one element, the total R-value must be determined, then 1 divided by the total of the R-values results in the U-value.)

C. Determine the HTM for heating by multiplying the U-value by the design temperature difference

Example: A component with a U-value of .08 in a situation where the design temperature difference is 65°F would have an HTM (heating) of 5.2 or, rounded off, 5

INFORMATION SHEET

D. Determine the HTM for cooling by multiplying the U-value by the equivalent temperature difference value from Table A-2 in *Manual J*

Example: A wood frame wall component with a U-value of .08 where the design temperature is 95°F in a situation where the daily temperature range is high would have an HTM (cooling) of 7.6, or rounded off, 7.5

V. Factors to consider when sizing heating equipment

A. Type of structure

B. Heat loss determined from design conditions

C. Temperature rise

(NOTE: A heating unit must have an air handling capacity large enough to produce an air temperature rise within an approved range; most units list the approved range on the rating plate and the information can also be found in the manufacturer's specifications.)

D. Static pressure

(NOTE: Heating systems must overcome the resistance from supply and return ducts and other components that contribute to resistance or static pressure.)

E. Output capacity should never be less than the estimated heating load or less than specified by local codes

F. Output capacity should never be more than 15 percent above the estimated heating load or more than specified by local codes

G. System design should be compatible with cooling load and projected cooling equipment

VI. Factors to consider when sizing cooling equipment

A. Type of structure

B. System design should be compatible with heating load and projected heating equipment

C. Heat gain determined from design conditions

INFORMATION SHEET

D. Cfm correctly related to humidity control

(NOTE: When air volume is decreased to remove more moisture from the air, it affects the capacity of the cooling unit.)

Example:

Daily temperature range	Cfm requirements per 12,000 Btuh (1 ton) of cooling capacity
Low	300
Medium	360
High	420

E. Output capacity should never be less than five percent below the estimated cooling load or less than specified by local codes

F. Output capacity should never be more than 12 percent above the estimated cooling load or more than specified by local codes

VII. Ways structural modifications can affect equipment selection

A. When equipment will facilitate the cooling load, but not the heating load, the amount of insulation in walls and over ceilings should be increased, thermopane or storm windows should be installed, and doors and windows weatherstripped

B. When equipment will facilitate the heating load, but not the cooling load, special consideration should be given to shading windows with drapes, shades, solar screens, roof overhangs, or permanent awnings

(NOTE: Inadequate insulation in walls and over ceilings can also contribute to heat gain.)

C. When equipment will faciliate the heating load, but not the cooling load, special consideration should be given to selecting light outside colors, especially light colored roofs

D. Obvious beneficial structural modification can contribute significantly to the conservation of vital energy and improve the compatibility of heating and cooling equipment

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ASSIGNMENT SHEET #1--ESTIMATE HEAT LOSS FOR A TEMPORARY RESIDENCE

Directions: A company that manufactures windmills needs to house employees who will be involved in a three-year experimental project. The company will use a prefabricated temporary residence constructed to provide an office for five employees and a crew area for six employees. The floor plan and specifications are shown in Figure 1. Using tables in *Manual J* and a "Form J-1 Worksheet," estimate the heat loss for the residence.

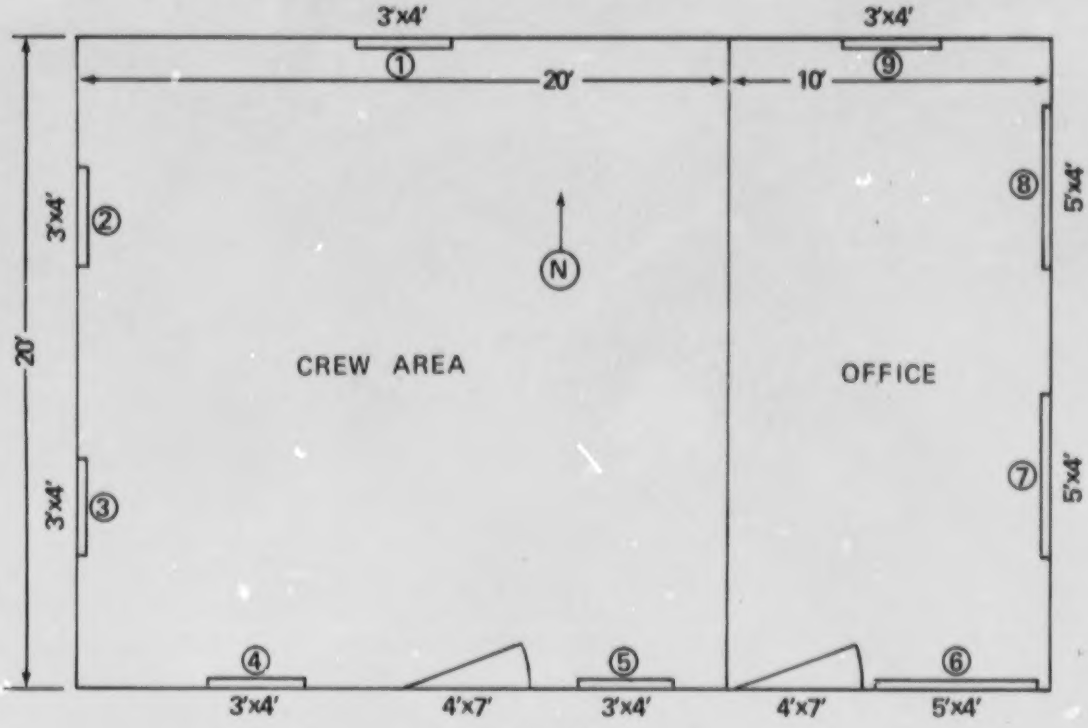


FIGURE 1

Construction specifications:

Walls--Wood frame with no insulation
Wall height--8' on the north, 10' on the south to facilitate a shed roof
Windows--Jalousie with storm sash; windows #7 and #8 have awnings that provide a 1' overhang
Doors--Wood with weatherstripping
Roof-ceiling combination--Wood with no insulation covered with asphalt roll roofing
Floors--Wood over supporting skids that form a vented area
Ducts--All will be in conditioned space
Location--Five miles west of Russell, Kansas
Inside design temperature: Winter-65, Summer-75

ASSIGNMENT SHEET #1

Procedure for heat loss calculation on Form J-1:

1. Complete winter design conditions on the front of Form J-1 to include outside temperature, inside temperature, and the design temperature difference for a geographical point five miles west of Russell, Kansas
2. List "Crew Area" as the name of room in column 1, and complete items 2 through 4 from construction specifications

   (NOTE: Since the construction building has a shed roof, the height of exposed walls north and south will be different and should be averaged as indicated in item 2-5 of *Manual J*.)
3. List "Office" as name of room in column 2 and complete items 2 through 4 from construction specifications

   (NOTE: Be sure to average height of exposed walls.)
4. Enter on line 5a, information column,the construction number for the type of exposed walls for both rooms

   (NOTE: For convenience, the column to the left of the "Entire House" column will be referred to as the "information" column.)
5. Enter in column 1, line 5a, the square footage of exposed walls in the crew area
6. Enter in column 2, line 5a, the square footage of exposed walls in the office
7. Enter on line 6a, information column, the construction number for the type of windows in both rooms
8. Enter on line 6a, information column, the correct HTM heating in the Htg block
9. Enter the total square footage of windows in the crew area on line 6a, column 1, in area block
10. Multiply the window HTM on line 6a by the square footage for windows in the crew area and enter in the Htg block on line 6a, column 1
11. Enter the total square footage of windows in the office on line 6a, column 2, in area block
12. Multiply the window HTM on line 6a by the square footage for windows in the office and enter in the Htg block on line 6a, column 2
13. Add the window Btuh heat loss figures for both rooms and enter the total in the Htg block on line 6a under "Entire House" column
14. Enter on line 8, information column, the construction number for the doors in both rooms
15. Enter on line 8, information column, Htg block, the correct HTM heating for the doors in both rooms

ASSIGNMENT SHEET #1

16. Enter on line 8, column 1, area block, the square footage of the door in the crew area

17. Multiply the door HTM Htg on line 8 by the square footage of the door in the crew area and enter on line 8, column 1, Htg block

18. Enter on line 8, column 2, area block, the square footage of the door in the office

19. Multiply the door HTM Htg on line 8 by the square footage of the door in the office and enter on line 8, column 2, Htg block

20. Add the door Btuh heat loss for both rooms and enter the total in the Htg block on line 8 under "Entire House" column

21. Enter on line 9a, information column, the construction number for the net exposed walls in both rooms

22. Enter on line 9a, information column, Htg block, the HTM Htg for the net exposed walls in both rooms

23. Subtract from line 5a, area, column 1, the total of lines 6a and 8, area, column 1, and enter on line 9a, area, column 1

24. Mutliply the net square footage of exposed walls in column 1 by the HTM Htg for net exposed walls, and enter on line 9a, Htg block, column 1

25. Subtract from line 5a, area, column 2, the total of lines 6a and 8, area, column 2, and enter on line 9a, area, column 2

26. Multiply the net square footage of exposed walls in column 2 by the HTM Htg for net exposed walls, and enter on line 9a, Htg block, column 2

27. Add the net exposed walls Btuh heat loss for both rooms and enter the total in the Htg block on line 9a, "Entire House" column

28. Enter on line 10a, information column, the construction number for the type of roofs over both rooms

29. Enter on line 10a, information column, the correct HTM Htg for the roof over both rooms

30. Enter on line 10a, area, column 1, the total square footage of the roof over the crew area

31. Multiply the roof HTM on line 10a by the total square footage of the roof over the crew area, and enter on line 10a, Htg block, column 1

32. Enter on line 10a, area, column 2, the total square footage of the roof over the office

33. Multiply the roof HTM on line 10a by the total square footage of the roof over the office, and enter on line 10a, Htg block, column 2

ASSIGNMENT SHEET #1

34. Add the roof Btuh heat loss for both rooms, and enter the total in the Htg block on line 10a, "Entire House" column

35. Enter on line 11a, information column, the construction number for the type of floor in both rooms

36. Enter on line 11a, information column, the correct HTM Htg for the floor in both rooms

37. Enter on line 11a, area, column 1, the total square footage of the floor in the crew area

38. Multiply the total square footage of the floor in the crew area by the HTM Htg for floors and enter on line 11a, Htg, column 1

39. Enter on line 11a, area, column 2, the total square footage of the floor in the office

40. Multiply the total square footage of the floor in the office by the HTM Htg for floors and enter on line 11a, Htg, column 2

41. Add the floor Btuh heat loss for both rooms, and enter the total in the Htg block on line 11a, "Entire House" column

42. Total all entries in the Htg blocks under "Entire House" column and enter on line 13, Htg block, "Entire House" column

43. Retain your completed heat loss estimate for use in a related assignment

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ASSIGNMENT SHEET #2--CALCULATE SHADED AND UNSHADED GLASS AREAS FOR USE IN HEAT GAIN ESTIMATES

Directions: Using Table A from the Form J-1 Worksheet and Table B-1 in *Manual J*, complete a table that will show the correct shaded and unshaded glass area for the temporary residence in Assignment Sheet #1

Procedure for completing Table A:

1. Enter in order the direction each window in the structure faces on line 1 of Table A

   (NOTE: To avoid confusion, number each window as it appears on the floor plan.)

   Example: 1. Direction which window faces N-1, W-2, W-3, S-4, S-5, etc.

2. Enter in order the total square footage of each window area on line 2 of Table A
3. Enter in order the width of each window on line 3 of Table A
4. Determine the shaded area per foot of overhang only for windows that are shaded by referring to Table B-1 and enter the figures beneath the windows they apply to on line 4 of Table A
5. Enter the width of the overhang for the windows that have overhang on line 5 of Table A
6. Enter the total square footage of shaded glass by multiplying the individual entries on line 4 by the appropriate individual entries on line 5, and enter on line 6 of Table A
7. Enter the total square footage of unshaded glass by subtracting the individual entries on line 6 from the appropriate individual entries on line 2, and enter on line 7 of Table A
8. Retain your completed Table A for use in a related assignment

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ASSIGNMENT SHEET #3--ESTIMATE HEAT GAIN FOR A TEMPORARY RESIDENCE

Directions: Using the floor plan and construction specifications outlined in Assignment Sheet #1, complete a Form J-1 Worksheet estimating heat gain for the residence.

Procedure for completing Form J-1:

1. Complete summer design conditions on the front of Form J-1 for Russell, Kansas, assuming an inside design temperature of 75°F

   (NOTE: For heat gain calculations, use the same Form J-1 Worksheet used for Assignment Sheet #1.)

2. Use the completed Table A on the back of Form J-1 Worksheet from Assignment Sheet #2
3. Enter on line 7, the HTM Clg for all windows facing north
4. Enter on line 7, the HTM Clg for all windows facing east and west
5. Enter on line 7, the HTM Clg for all windows facing south
6. Calculate the square footage for all north facing windows in the crew area and enter the figure on line 7, area, column 1
7. Calculate the square footage for all west facing windows in the crew area and enter the figure on line 7, area, column 1
8. Calculate the square footage for all south facing windows in the crew area and enter the figure on line 7, area, column 1
9. Multiply the HTM Clg on line 7 north by the square footage in column 1, area, and enter in the Clg block under column 1 opposite line 7 north
10. Multiply the HTM Clg on line 7 east and west by the square footage in column 1, area, and enter in the Clg block under column 1 opposite line 7 east and west
11. Multiply the HTM Clg on line 7 south by the square footage in column 1, area, and enter in clg block under column 1 opposite line 7 south
12. Calculate the square footage for all north facing windows in the office and enter the figure on line 7, area, column 2
13. Calculate the square footage for all east facing windows in the office with adjustments made from Table A and enter the figure on line 7, area, column 2
14. Calculate the square footage for all south facing windows in the office with adjustments made from Table A and enter the figure on line 7, area, column 2
15. Multiply the HTM Clg on line 7 north by the square footage in column 2, area, and enter in the Clg block under column 2 opposite line 7 north

ASSIGNMENT SHEET #3

16. Multiply the HTM Clg on line 7 east by the square footage in column 2, area, and enter in the Clg block under column 2 opposite line 7 east

17. Multiply the HTM Clg on line 7 south by the square footage in column 2, area, and enter in the Clg block under column 2 opposite line 7 south

18. Add the totals in columns 1 and 2 under the Clg block on line 7 north, and enter this total under Clg block in "Entire House" column on line 7 north

19. Add the totals in columns 1 and 2 under the Clg block on line 7 east and west, and enter this total under Clg block in "Entire House" column on line 7 east and west

20. Add the totals in columns 1 and 2 under the Clg block on line 7 south, and enter this total under Clg block in "Entire House" column on line 7 south

21. Select the proper HTM (cooling) for doors from Table 5, and enter it in the Clg block in the information column

22. Multiply the HTM (cooling) for doors by the square footage already entered in column 1, area, and put the total under the Clg block in column 1

23. Multiply the HTM (cooling) for doors by the square footage already entered in column 2, area, and put the total under the Clg block in column 2

24. Add the totals in the Clg blocks in columns 1 and 2 on line 8, and enter the figure on line 8 in the Clg block under "Entire House" column

25. Select the correct HTM (cooling) for net exposed walls and enter on line 9a under the Clg block in the information column

26. Multiply the HTM (cooling) for net exposed walls by the square footage already entered in column 1, area, and put the total under the Clg block in column 1 on line 9a

27. Multiply the HTM (cooling) for net exposed walls by the square footage already entered in column 2, area, and put the total under the Clg block in column 2 on line 9a

28. Add the totals in the Clg blocks, line 9a, in columns 1 and 2, and enter the figure in the "Entire House" column in the Clg block on line 9a

29. Select the correct HTM (cooling) for roofs and enter in the Clg block in the information column on line 10a

    (NOTE: Remember that the roof is covered with a dark material.)

30. Multiply the HTM (cooling)for roofs by the square footage already entered in column 1, area, and put the total under the Clg block in column 1 on line 10a

31. Multiply the HTM (cooling) for roofs by the square footage already entered in column 2, area, and put the total under the Clg block in column 2 on line 10a

ASSIGNMENT SHEET #3

32. Add the totals in the Clg blocks in columns 1 and 2 on line 10a, and enter the figure on line 10a in the Clg block under the "Entire House" column

33. Select the correct HTM (cooling) for floors and enter in the Clg block in the information column on line 11a

34. Multiply the HTM (cooling) for floors by the square footage already entered in column 1, area, and put the total under the Clg block in column 1 on line 11a

35. Multiply the HTM (cooling) for floors by the square footage already entered in column 2, area, and put the total under the Clg block in column 2 on line 11a

36. Add the totals in the Clg blocks on line 11a in columns 1 and 2, and enter the figure on line 11a in the Clg block under "Entire House" column

37. Compute the heat gain from people for the crew area and enter on line 16 in the Clg block under column 1

38. Compute the heat gain from people for the office and enter on line 16 in the Clg block under column 2

39. Add the totals for heat gain from people and enter the figure on line 16 in the Clg block under the "Entire House" column

40. Total all entries in the Clg blocks under column 1 and enter on line 17 column 1

41. Total all entries in the Clg blocks under column 2 and enter on line 17 column 2

42. Add the totals on line 17, Clg blocks, columns 1 and 2, and enter the figure on line 17 in the "Entire House" column

    (NOTE: Since there is no duct Btuh gain, line 18 will have no entries.)

43. Transfer all subtotals to the correct places on line 19

44. Check the total on line 19 under the "Entire House" column by adding all figures in the Clg blocks under "Entire House" column

45. Multiply by 1.3 the figure in the Clg block, "Entire House" column, on line 19

46. Enter the total Btuh gain for the structure in the Clg block under the "Entire House" column on line 20

47. Retain your assignment sheet for use in a related assignment

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ASSIGNMENT SHEET #4--EVALUATE THE ADDITION OF INSULATION IN RELATION TO HEAT LOSS AND HEAT GAIN

Directions: Using the Form J-1 Worksheet from Assignment Sheets #1, #2, and #3, enter "Entire House" in column number 3, add all square footage totals from columns 1 and 2, and place these totals in the appropriate blocks under the new "Entire House" column

Procedure for completing Form J-1:

1. Assume the residence has double-hung windows with double glass and the HTM (heating) is 65
2. Enter on line 6a Htg under the new "Entire House" column, the correct Btuh figure assuming the residence has double-hung windows with double glass and the HTM (heating) is 65
3. Enter on line 8 Htg under the new "Entire House" column, the correct Btuh figure assuming the residence has wood doors weatherstripped and with storm doors and the HTM (heating) is 85
4. Enter on line 9a Htg under the new "Entire House" column, the correct Btuh figure assuming the residence has wood walls with batt insulation 3-1/2" thick and an HTM (heating) of 4
5. Enter on line 10a Htg under the new "Entire House" column the correct Btuh figure assuming the residence has roof-ceiling combination with 6" of insulation and an HTM (heating) of 3
6. Enter on line 11a Htg under the new "Entire House" column the correct Btuh figure assuming the residence has a floor with 3" of insulation and an HTM (heating) of 5
7. Enter on line 13 Htg under the new "Entire House" column the subtotal Btuh loss
8. Divide the subtotal on line 13 under the new "Entire House" column by the subtotal on line 13 under the original "Entire House" column, convert the figure to a percentage, and enter it on line 13 next to the listing of Sub Total Btuh Loss (round the figure off to the nearest percentage)
9. Determine the actual dollar amount that could be saved in heating costs over a 3-year period if the temporary residence were insulated as outlined in this assignment sheet, that the average annual cost of heating the uninsulated structure were $1,200, and that Btuh heat loss is directly proportional to the cost of operating heating equipment
10. Enter the actual dollar amount determined in procedure 8 on line 15 next to Total Btuh Loss
11. Assume the actual dollar amount saved for operating cooling equipment would be equal to 70% of the savings realized for operating heating equipment if the building were insulated

ASSIGNMENT SHEET #4

12. Enter the actual dollar amount determined in procedure 10 on line 18 next to Duct Btuh Gain

13. Total the entries made in procedures 9 and 11 and enter the actual dollar amount just below line 21, Btuh for Air Quantities

14. Evaluate the addition of insulating factors in relation to the cost of operating heating and cooling as:

    a. Significant

    b. Moderate

    c. Insignificant

15. Evaluate the addition of insulating factors in a situation where the additional cost of insulation would exactly equal the amount of savings over a 36-month period by classifying them as:

    a. Insignificant because insulation materials are in short supply

    b. Significant because even if the two costs balance out, there is still an appreciable savings of vital energy

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. Outside temperature: 0°F
   Inside temperature: 65°F
   Design temperature difference: 65 degrees

2. Name of room: Crew Area
   Running Ft Exposed Wall: 60
   Room Dimensions, ft: 20 x 20
   Ceiling Ht, Ft: 9 (averaged)
   Directions Room Faces: N, W, S

3. Name of room: Office
   Running Ft Exposed Wall: 40
   Room Dimensions, ft: 10 x 20
   Ceiling Ht, Ft: 9 (averaged)
   Directions Room Faces: N, E, S

4. 10 (a)
5. 540
6. 360
7. 5 (b)
8. 75
9. 60
10. 4500
11. 72
12. 5400
13. 9900
14. 9 (b)
15. 155
16. 28
17. 4340
18. 28
19. 4340
20. 8680
21. 10 (a)
22. 16
23. 452
24. 7232
25. 260
26. 4160
27. 11392
28. 16 (a)
29. 20
30. 400
31. 8000
32. 200
33. 4000
34. 12000
35. 17 (b)
36. 18
37. 400
38. 7200
39. 200
40. 3600
41. 10800
42. 52772
43. 52772
44. N/A

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2

1. N-1, W-2, W-3, S-4, S-5, S-6, E-7, E-8, N-9
2. 12, 12, 12, 12, 12, 20, 20, 20, 12
3. 3, 3, 3, 3, 3, 5, 5, 5, 3
4. 0, 0, 0, 0, 0, 0, 1, 1, 0
5. 0, 0, 0, 0, 0, 0, 2, 2, 0
6. 0, 0, 0, 0, 0, 0, 2, 2, 0
7. 12, 12, 12, 12, 12, 20, 18, 18, 12
8. N/A

Assignment Sheet #3

1. Outside: 100°F
   Inside: 75°F
   North Latitude: 40 degrees
   Daily Range: H
2. As recorded in Assignment Sheet #2
3. 35
4. 95
5. 55
6. 12
7. 24
8. 24
9. 420
10. 2280
11. 1320
12. 12
13. 36
14. 20
15. 420
16. 3420
17. 1100
18. 840
19. 5700
20. 2420
21. 13.5
22. 756
23. 378
24. 5340
25. 7.5
26. 3390
27. 1950
28. 5340
29. 13
30. 5200
31. 2600
32. 7800
33. 5
34. 2000
35. 1000
36. 1000
37. 1800
38. 1500
39. 3300
40. 16788
41. 12368
42. 29156
43. 29156
44. 29156
45. 37903
46. 37903
47. N/A

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

1. 8580
2. 4760
3. 2848
4. 1800
5. 3000
6. 20988
7. 40% (39.7 rounded off)
8. $1,440
9. $1,440
10. N/A
11. $1,008
12. $2,448
13. a
14. b

(NOTE: Answers should be modified as changes are made in *Manual J.*)

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

NAME ______________________________

TEST

1. Match the terms on the right with their correct definitions.

______a. The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit

______b. The unit used to express hourly heat flow

______c. The movement of heat from one substance or region to another

______d. An index of heat transfer through one square foot of a structural component at specific design conditions

______e. The rating given to a material's ability to resist heat transfer

______f. One divided by the total R-values of a component

______g. The total square footage, including doors and windows, of walls exposed to the outside

______h. The total square footage, excluding doors and windows, of walls exposed to the outside

______i. A wall separating a conditioned space from an unconditioned space

______j. Walls of upper rooms exposed to attic temperatures

______k. Sensible heat gain produced by people and appliances

______l. Heating and cooling lost or gained because of air leakage and heat transfer in ducts

1. Ventilation
2. Gross exposed walls
3. Ton of refrigeration
4. Btu
5. Infiltration
6. HTM
7. Internal heat gain
8. Cfm
9. Btuh
10. Heat transfer
11. U-value
12. Net exposed walls
13. Duct loss and duct gain
14. Knee walls
15. R-value
16. Exposed partition

_____m. Controlled air brought into a structure

_____n. Uncontrolled air that leaks into a structure

_____o. Cubic feet per minute

_____p. A refrigerating effect equal to 12,000 Btuh

2. Select true statements concerning the value of standardized procedures in estimating residential heating and cooling loads by placing an "X" in the appropriate blanks.

   _____a. Charts and tables in most load estimating forms reflect years of cumulative technical information through which the air conditioning industry has improved and simplified the load calculation process

   _____b. Residential heating and cooling load estimates can be calculated only by engineers or scientists because the forms are filled with sophisticated mathematical formulas

3. List four factors in determining heat loss and heat gain.

   a.

   b.

   c.

   d.

4. Select true statements concerning the steps in calculating heat transfer multipliers by placing an "X" in the appropriate blanks.

   _____a. Determine the R-value of the construction component

   _____b. Determine the U-value of the construction component

   _____c. Determine the HTM for heating by multiplying the U-value by the design temperature difference

   _____d. Determine the HTM for cooling the same way as the HTM for heating

5. Select true statements concerning factors to consider when sizing heating equipment by placing an "X" in the appropriate blanks.

   _____a. Type of structure

   _____b. Heat loss determined from design conditions

   _____c. Temperature rise

   _____d. Static pressure

_____e. Output capacity should never be less than the estimated heating load or less than specified by local codes

_____f. Output capacity should never be more than 15 percent above the estimated heating load or more than specified by local codes

_____g. Since the heating system design is most important, it should be completed before sizing cooling equipment

6. Select true statements concerning factors to consider when sizing cooling equipment by placing an "X" in the appropriate blanks.

_____a. Type of structure

_____b. System design should be compatible with heating load and projected heating equipment

_____c. Heat gain determined from design conditions

_____d. Cfm correctly related to humidity control

_____e. Output capacity should never be less than ten percent below the estimated cooling load or less than specified by local codes

_____f. Output capacity should never be more than 20 percent above the estimated cooling load or more than specified by local codes

7. List three ways structural modifications can affect equipment selection.

a.

b.

c.

8. Demonstrate the ability to:

a. Estimate heat loss for a temporary residence.

b. Calculate shaded and unshaded glass areas for use in heat gain estimates.

c. Estimate heat gain for a temporary residence.

d. Evaluate the addition of insulation in relation to heat loss and heat gain.

(NOTE: If these items have not been accomplished prior to the test, ask your instructor when they should be completed.)

RESIDENTIAL HEAT LOSS AND HEAT GAIN
UNIT VI

ANSWERS TO TEST

1.	a.	4	f.	11	k.	7	p.	3
	b.	9	g.	2	l.	13		
	c.	10	h.	12	m.	1		
	d.	6	i.	16	n.	5		
	e.	15	j.	14	o.	8		

2. a

3. Any four of the following:

    a. Size of structure and the insulating qualities of its components
    b. Outside design temperature for heat loss
    c. Daily temperature range for heat gain
    d. Inside design temperature
    e. Design temperature difference for heat loss
    f. HTM heating or HTM cooling

4. a, b, c

5. a, b, c, d, e, f

6. a, b, c, d

7. Any three of the following:

    a. When equipment will facilitate the cooling load, but not the heating load, the amount of insulation in walls and over ceilings should be increased, thermopane or storm windows should be installed, and doors and windows weatherstripped

    b. When equipment will facilitate the heating load, but not the cooling load, special consideration should be given to shading windows with drapes, shades, solar screens, roof overhangs, or permanent awnings

    c. When equipment will facilitate the heating load, but not the cooling load, special consideration should be given to selecting light outside colors, especially light colored roofs

    d. Obvious beneficial structural modification can contribute significantly to the conservation of vital energy and improve the compatibility of heating and cooling equipment

8. Evaluated to the satisfaction of the instructor

DUCT DESIGN AND SIZING
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify types of supply duct systems, list advantages and disadvantages of air duct supply and return systems, and solve problems using the friction loss chart and friction chart. The student should also be able to design an air distribution system from a drawing. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to duct design and sizing with their correct definitions.
2. Identify types of supply duct systems.
3. Match factors affecting system design with the effects they have on the system.
4. Match major steps of air system design with the correct procedures for completing each step.
5. Select factors affecting return air duct design.
6. List four locations of registers and grilles.
7. List advantages and disadvantages for locations of registers and grilles.
8. Describe four climatic zone conditions.
9. Name four factors to consider in the distribution of conditioned air.
10. Match significant room air patterns as determined by outlet placement with their recommended velocities.
11. Solve problems using the friction loss per 100 feet chart.
12. Solve problems using the friction chart.
13. Design an air distribution system from a drawing.
14. Demonstrate the ability to:
    a. Determine the pressure drop across an evaporator coil.
    b. Determine the CFM being delivered by a given forced air system.

DUCT DESIGN AND SIZING
UNIT VII

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information, assignment, and job sheets.

VI. Assist students in use of transparencies in developing answers to sample problems based on assignment sheets.

VII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Types of Supply Duct Systems
      2. TM 2--Equivalent Length and Effective Length of Fittings and Ducts
      3. TM 3--Duct Fittings and Equivalent Lengths (Group 1)
      4. TM 4--Duct Fittings and Equivalent Lengths (Group 3)
      5. TM 5--Duct Fittings and Equivalent Lengths (Group 4)
      6. TM 6--Duct Fittings and Equivalent Lengths (Group 5)
      7. TM 7--Duct Fittings and Equivalent Lengths (Group 6)
      8. TM 8--Duct Fittings and Equivalent Lengths (Group 7)
      9. TM 9--Rectangular Duct Equivalents
      10. TM 10--Climatic Zone Map for System Selection
      11. TM 10--Friction Loss Per 100 Feet Chart

12. TM 12--Suggested Static Pressures for Duct Design

13. TM 13--Friction Chart

D. Assignment sheets

1. Assignment Sheet #1--Solve Problems Using the Friction Loss per 100 feet Chart

2. Assignment Sheet #2--Solve Problems Using the Friction Chart

3. Assignment Sheet #3--Design an Air Distribution System from a Drawing

E. Answers to assignment sheets

F. Job sheets

1. Job Sheet #1--Determine the Pressure Drop Across an Evaporator Coil

2. Job Sheet #2--Determine the CFM Being Delivered by a Given Forced Air System

G. Test

H. Answers to test

II. References:

A. *Manual 4, Installation Techniques for Perimeter Heating and Cooling.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Ninth Edition, 1964.

B. *Manual E, Room Air Distribution Considerations.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1965.

C. *Manual G, Selection of Distribution System.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1965.

D. *Manual K, Equipment Selection and System Design Procedures.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Second Edition, 1973.

E. *Understanding the Friction Chart.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), 1967.

F. "Preliminary Notes on Manual D." Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Unpublished new manual in committee.

III. Additional materials:

A. *Manual A, What is Comfort Air Conditioning?* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1961.

B. *Manual B, Principles of Air Conditioning.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1970.

C. *Manual C, What Makes a Good Air Conditioning System.* Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), First Edition, 1966.

D. "The Total Comfort System Story." Washington, DC 20036: Air-Conditioning Contractors of America (ACCA), Customer education pamphlet.

DUCT DESIGN AND SIZING
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Proprietary system--Heating or cooling equipment which incorporates its own air distribution system as part of its design

B. Static pressure--The measure of the resistance of ducts, grilles, filters, and other surfaces to the flow of air

(NOTE: This is the pressure within duct work, which is positive if the duct is a supply duct and negative if the duct is a return duct.)

C. Plenum--A box-like fitting into which an air handler discharges air or from which the air handler receives return air in a duct system

D. Duct--Tube or channel through which air is conveyed or moved

E. Boot--A duct fitting which adapts the duct to a wall stack or to a register or grille

F. Take-off--The point of departure from a duct to which a duct fitting is attached to accomplish branching of ductwork

G. Equivalent length--Resistance to air flow created by the structural design of a fitting, indicated by the length of straight duct which would offer the same resistance

H. Effective length--The sum of the measured length of straight duct plus the equivalent lengths of fittings in the duct

I. Actual measured length--The physical measurement of a duct

J. Damper--Device used to control the volume of air flow passing through or out of a duct or register

K. Vane--A fixed or adjustable device used to direct air flow

L. Grille--A louvered opening usually found in a return air opening

M. Register--A grille that has a regulating damper device for controlling amount of air flow and vanes to control air direction

N. Diffuser--A register which delivers fan shaped patterns of air into a room

O. Equal friction method--A method of duct design used to meter air flow so that air is distributed proportionately to all conditioned spaces

(NOTE: This commonly used basis for duct design means areas requiring more air, or distant areas requiring the same air volume, require larger ducts to overcome or "equalize" the increased friction.)

INFORMATION SHEET

P. System pressure--The sum of the negative and positive static pressures being exerted by a blower

Q. Convection currents--Air currents set in motion by cooling or warming of air brought in contact with hot or cold surfaces such as walls or windows

R. Stratification of air--Condition in which there is little (15 fpm) or no air movement in room; air lies in temperature layers

(NOTE: In the summer this is identified as the region near the ceiling where a layer of smoke will hang for some time; in the winter it is identified as a cold layer of air near the floor.)

S. Temperature gradient--Temperature change from one level or stratum to the next as in the change from floor to ceiling

T. Cascade (waterfall) effect--The transfer of large masses of air due to convection currents in a structure often caused by warm air rising and cooler air falling through building accesses such as stairs

U. Wall stack--A thin, rectangular duct which runs vertically inside a wall

V. Ceiling or wall effect--A peculiar ability of moving air to cling to a ceiling or a wall

W. Fpm--Feet per minute, a measurement of velocity

X. Terminal velocity--An arbitrary maximum velocity of an air stream which spreads or drops into a living area, usually considered comfortable at 35-50 fpm

Y. Throw--The distance a high sidewall supply outlet delivers air before slowing to terminal velocity

Z. Drop--The distance air falls vertically below a high sidewall supply outlet before slowing to terminal velocity

AA. Spread--The fan-like width of an air stream from a diffusing type supply outlet at the point of terminal velocity

BB. Primary air--A mixture of supply air from an outlet and room air at velocities above 150 fpm

CC. Entrained air--Room air which is dragged into the primary air and raised to higher velocities inside the primary air envelope

DD. Floor warming--Floor heating by burying ducts in concrete slab floors or by running supply ducts under floors

EE. Free area--Net area of a register or grille after subtracting areas of vanes or dampers, typically 70% of gross face area or as specified by manufacturer

INFORMATION SHEET

FF. Pressure drop--The phenomenon of static pressure diminishing from maximum at the blower to zero after passing through an outlet regardless of duct length

GG. IWG--Inches water gauge

II. Types of supply duct systems (Transparency 1)

A. Radial or spider

B. Trunk and branch

1. Reducing plenum
2. Extended plenum

C. Perimeter loop

1. Trunk duct
2. Radial duct

III. Factors affecting system design and the effects that they have on the system

A. Duct length

1. Volume--Greater duct length reduces volume of air to be delivered
2. Pressure--Greater duct length increases static pressure and resistance to air flow
3. Duct gain or loss--Greater duct length increases temperature of cold air or reduces temperature of warm air passing through the duct

B. Equivalent length--Changes in shape or direction of ducts will reduce volume of air flow because of increased resistance caused by air flow friction (Transparency 2)

C. Effective length (Transparency 2)

1. Prime factor used to determine duct diameter for a given pressure in the system
2. Determined by adding the actual duct work length plus the equivalent length of fittings

D. System pressure

1. Prime factor used to determine duct diameter for a given air volume in a system

INFORMATION SHEET

2. Selection is made after determining capability of equipment blower
3. Apportioned between supply ducts and return ducts

E. Design air volume

1. Transmits the total heat available from the heat source proportional to the amount of air delivered
2. When heating, the temperature will rise if the amount of air is reduced, and the temperature will fall if the amount of air is increased

F. Pressure drop per 100 feet--Affects the selection of the duct diameter; if the factor is too small, the duct diameter will be too large

G. Temperature rise

1. A decrease in air volume will result in an increase in temperature rise
2. An increase in air volume will result in a decrease in temperature rise

H. Duct wrap (insulation)--Reduces heat loss or heat gain in duct and eliminates condensation

I. Supply outlets--Size, design, and location affect the efficiency of the system and degree of comfort

IV. Major steps in air system design and procedures to follow in completing each step

A. Select air distribution system

1. Determine climatic region
2. Determine design of structure
3. Determine location of ducts
4. Determine best type of distribution system

B. Select heating and cooling equipment

1. Calculate total system load
2. Calculate heating and cooling CFM
3. Determine appropriate type of equipment to be used

INFORMATION SHEET

4. Select proper sized unit for heating

5. Select condensing unit and evaporator coil for cooling

6. Determine location of condensing unit, heating equipment, and thermostat

C. Lay out and size duct work (Transparencies 3, 4, 5, 6, 7, 8 and 9)

1. Determine appropriate location of duct work

2. Calculate number of outlet and inlet openings

3. Calculate the CFM required for each outlet

4. Determine the type of duct to be used and draw the runs

5. Obtain the equivalent length of fittings

6. Determine the total effective length of ducts

7. Determine the external static pressure drop per 100 ft.

8. Size duct using appropriate charts

D. Select registers and grilles for supply and return air

1. Examine floor plan to determine appropriate outlet register

2. Select appropriate registers based on correct distribution patterns

3. Select the proper return air grille size

V. Factors affecting return air duct design

A. Return air inlets are not normally placed in a kitchen or bathroom

B. An optimum system has a return air inlet in each bedroom

C. Return air inlets are normally placed so that air is not dragged over 30 feet from a supply

D. Return air duct systems must be designed for a design air volume equal to or greater than the supply air volume

E. Return air inlets should be placed on every level of a split level residence

(NOTE: In two story residences and split level houses with only one system, the upstairs return air system should be oversized by at least 10%; in small ranch houses, 1600 sq. ft. or less, a simple one return trunk duct is adequate.)

INFORMATION SHEET

F. Combined return air pressure and supply pressure must not exceed total available static pressure of the blower

(NOTE: Return design pressure is usually .1 inch static pressure (s.p.) or less to allow greater pressure to be used in supply system.)

G. Return air inlets are usually placed on inside walls which allows shorter duct work

VI. Locations of registers and grilles

A. Perimeter (radial, loop, or trunk and branch)

B. High inside wall

C. Low inside wall

D. Ceiling

VII. Advantages and disadvantages for locations of registers and grilles

A. Perimeter systems

1. Advantages

a) Delivers conditioned air at point of greatest heat loss and heat gain, which is the outside of the structure

(NOTE: These are points such as doors, windows, and exposed walls where heat loss and heat gain are greatest.)

b. Allows fewer air returns which are generally located in inner areas of structure

c. Delivers the highest level of comfort of any system

2. Disadvantages

a. More costly than many other systems

b. May be subject to water problems if ducts are buried under the slab

B. High inside wall system

1. Advantages

a. Supply outlets are located central to main trunk duct, so shorter ducts can be used

b. Pressure is less so smaller blower may be used

INFORMATION SHEET

- c. Doesn't interfere with furniture placement
- d. Permits longer periods of blower operation
- e. Well suited for cooling in areas where heating is of less importance
- f. Less costly installation

2. Disadvantages
   - a. Heating is more difficult because of stratification
   - b. Areas of greatest heat loss and gain such as windows are difficult to condition unless special attention is paid to selection of registers

C. Low inside wall system

1. Advantages
   - a. Supply outlets are located close to the blower
   - b. Installation is less costly
2. Disadvantages
   - a. Proper air distribution is difficult
   - b. High air velocities must be avoided
   - c. Furniture placement is difficult
   - d. Difficult to use as a cooling system
   - e. Diffuser vanes must be adjusted seasonally

D. Ceiling

1. Advantages
   - a. Doesn't interfere with furniture placement
   - b. Can be located in center of room or near outside wall
   - c. Well suited for summer cooling
   - d. Return air can be located on either inside or outside wall, near the floor

INFORMATION SHEET

2. Disadvantages

    a. Proper selection of supply registers is critical

    b. Doesn't heat floors directly

    c. Can cause room air stratification and large air temperature gradients

VIII. Climatic zone conditions (Transparency 10)

A. Zone A

1. Cold weather is more severe and more prolonged

2. Summers are relatively mild

B. Zone B

1. Less severe winters than zone A

2. Hotter days for extended periods

C. Zone C

1. Has mild winters

2. Has hot summers

D. Zone A1--Has the characteristics of zone A except that summer temperatures are, on the average, higher than zone A

(NOTE: The Air Conditioning Contractors of America (ACCA) have three comfort ratings for air conditioning systems; the recommended level will provide occupants basic comfort requirements, the next lowest rating is acceptable, but the lowest rating is not acceptable.)

Example: A high inside wall supply is recommended in zone C, acceptable in zone B, but not acceptable in zones A-1 or A

IX. Factors to consider in distribution of conditioned air

A. Velocity of primary air

B. Desired temperature of room air

C. Proper sizing and location of grilles and registers to minimize noise and discomfort from drafts

INFORMATION SHEET

D. Velocity of air in duct system

1. Trunk ducts--1000 fpm

2. Branch ducts--500-750 fpm

(NOTE: Because the sensation of drafts is greater with cold air, velocities of 25 to 35 fpm are recommended for an occupied space, but velocities from 20 to 50 fpm are acceptable; velocities lower than 15 fpm create stagnant air, and velocities over 65 fpm create uncomfortable drafts.)

X. Significant room air patterns as determined by outlet placement and their recommended velocities

(NOTE: These room air patterns have been determined by research conducted at the University of Illinois.)

A. Floor diffusers--450 fpm

B. Baseboard diffusers--700 fpm

C. High sidewall registers--350-500 fpm

D. Low sidewall registers--500 fpm

(NOTE: Inadequate velocity from any diffuser or register will cause primary cold air to drop into occupied space before reaching terminal velocity.)

XI. Steps in using the friction loss per 100 feet chart (Transparency 11)

(NOTE: The friction chart and friction loss per 100 ft. chart were developed by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) for use by all air conditioning and heating contractors, and the charts for 10 CFM to 2000 CFM will cover all residential situations.)

A. Obtain the available static pressure from the furnace nameplate or manufacturer's data

B. Take available static pressure and apportion for supply and return duct system (Transparency 12)

C. Locate the supply or return static pressure at the top of the friction loss per 100 ft. chart

(NOTE: This procedure will apply to supply and return static pressure.)

D. Determine the effective length of the first duct and locate on left side of friction loss per 100 ft. chart

INFORMATION SHEET

E. Find the intersection of the column and row on the chart to determine friction loss per 100 ft. of the first duct

F. Repeat steps D and E for each remaining duct

XII: Procedures for using the friction chart (Transparency 13)

A. Obtain the friction loss per 100 ft. for the first duct

B. Locate the friction loss per 100 ft. at the bottom of the friction chart

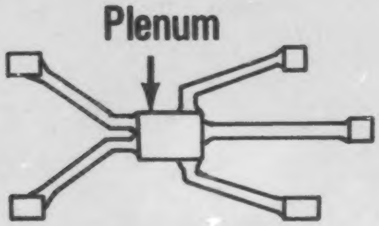
C. Follow the friction loss line upward to its intersection with the desired CFM (from plans)

D. Select the larger duct size of the two possible sizes as indicated on the chart

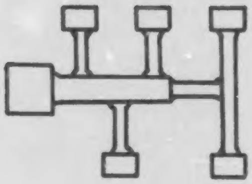
E. Select the air velocity at its intersection with the size of duct selected and cfm desired

(NOTE: The round ducts commonly used in residential applications are available commercially in even inches through 8" diameter; 9" round ducts are seldom used in modern construction, and larger ducts are available only in even inches of diameter; rectangular ducts may be built to any size.)

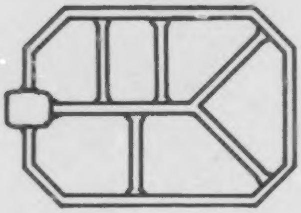
Types of Supply Duct Systems



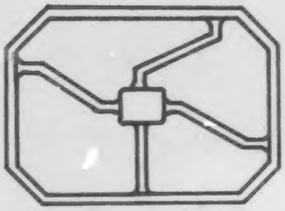
Radial or Spider



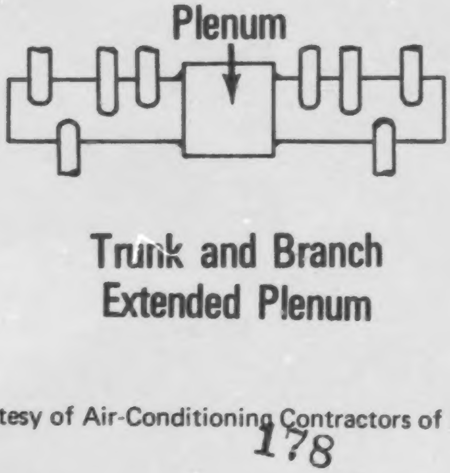
Trunk and Branch
Reducing Plenum



Perimeter Loop
Trunk Duct



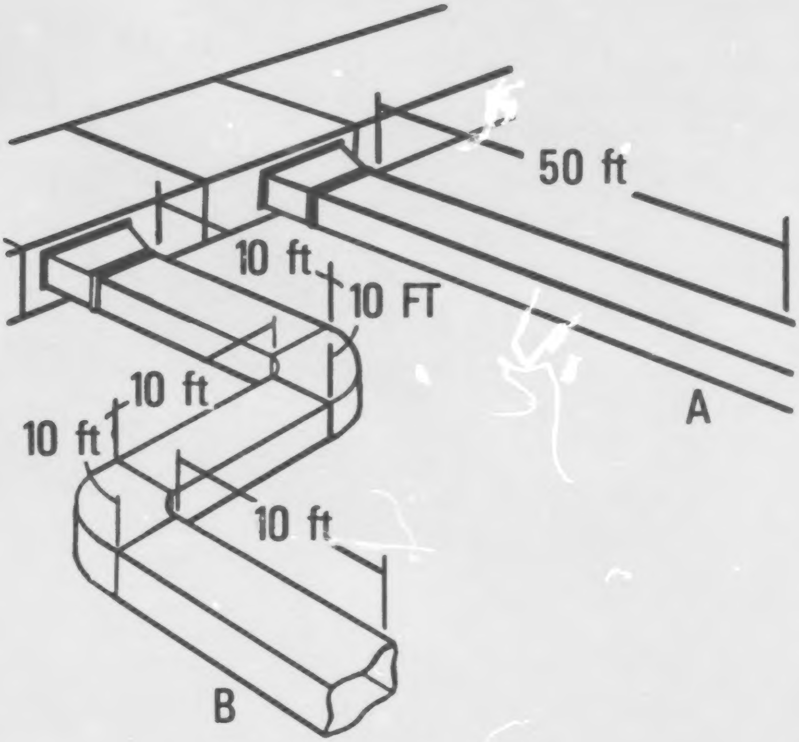
Perimeter Loop
Radial Duct



Trunk and Branch
Extended Plenum

Courtesy of Air-Conditioning Contractors of America

Equivalent Length and Effective Length of Fittings and Ducts



The effective length of Duct B is equal to the effective length of Duct A. The effective length of Duct B is obtained by adding equivalent length of fittings to actual measured duct length.

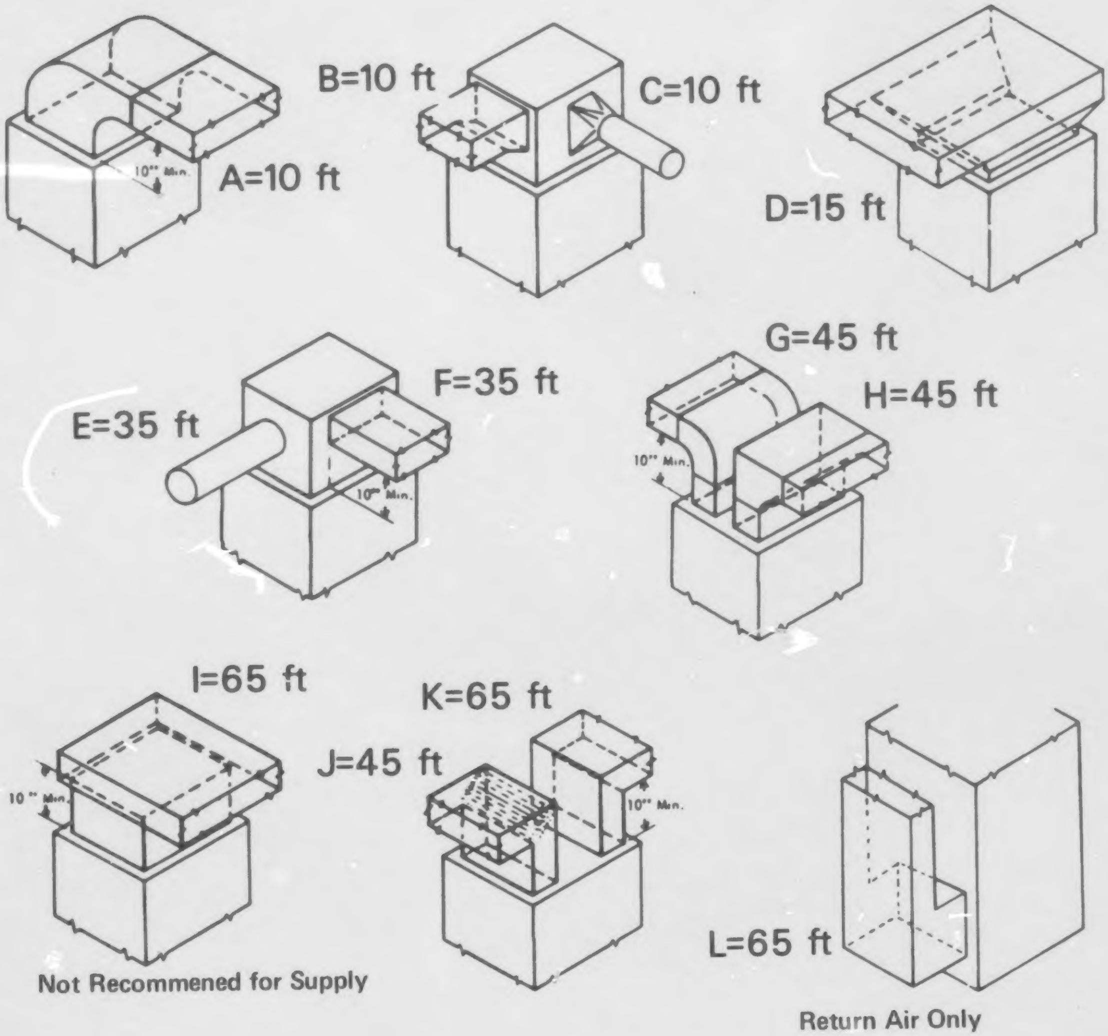
Courtesy of Air-Conditioning Contractors of America

Duct Fittings and Equivalent Lengths

(Group 1)

Supply and Return Air Take-Off Plenum Fittings

(These Fittings May Also be Installed on Plenums for Counter Flow Units.)



Not Recommened for Supply

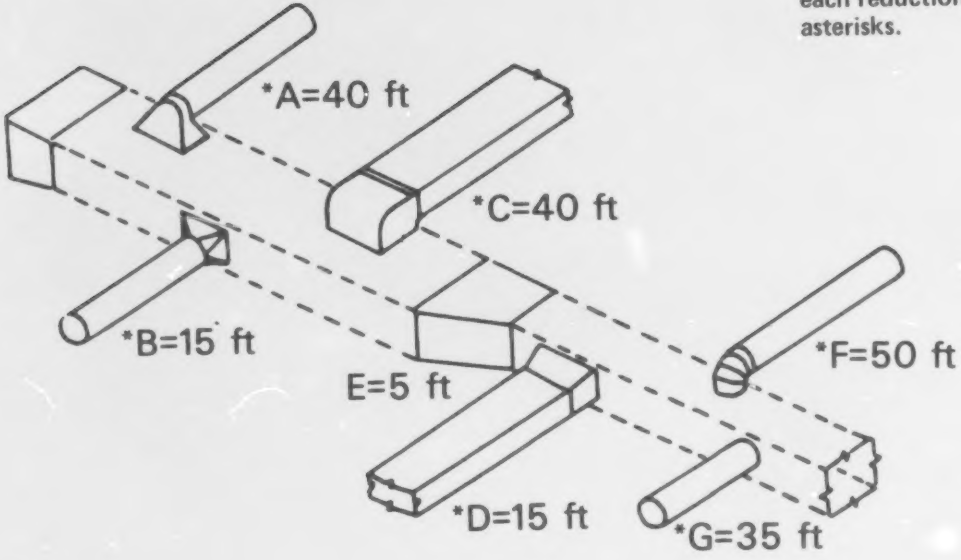
Return Air Only

Courtesy of Air-Conditioning Contractors of America

Duct Fittings and Equivalent Lengths

(Group 3)

Extended Plenum Fittings



Add 25 equiv. feet to each of the 3 fittings nearest the unit in each trunk duct and after each reduction as shown by asterisks.

Drawings of Various Fittings with Equivalent Lengths Shown

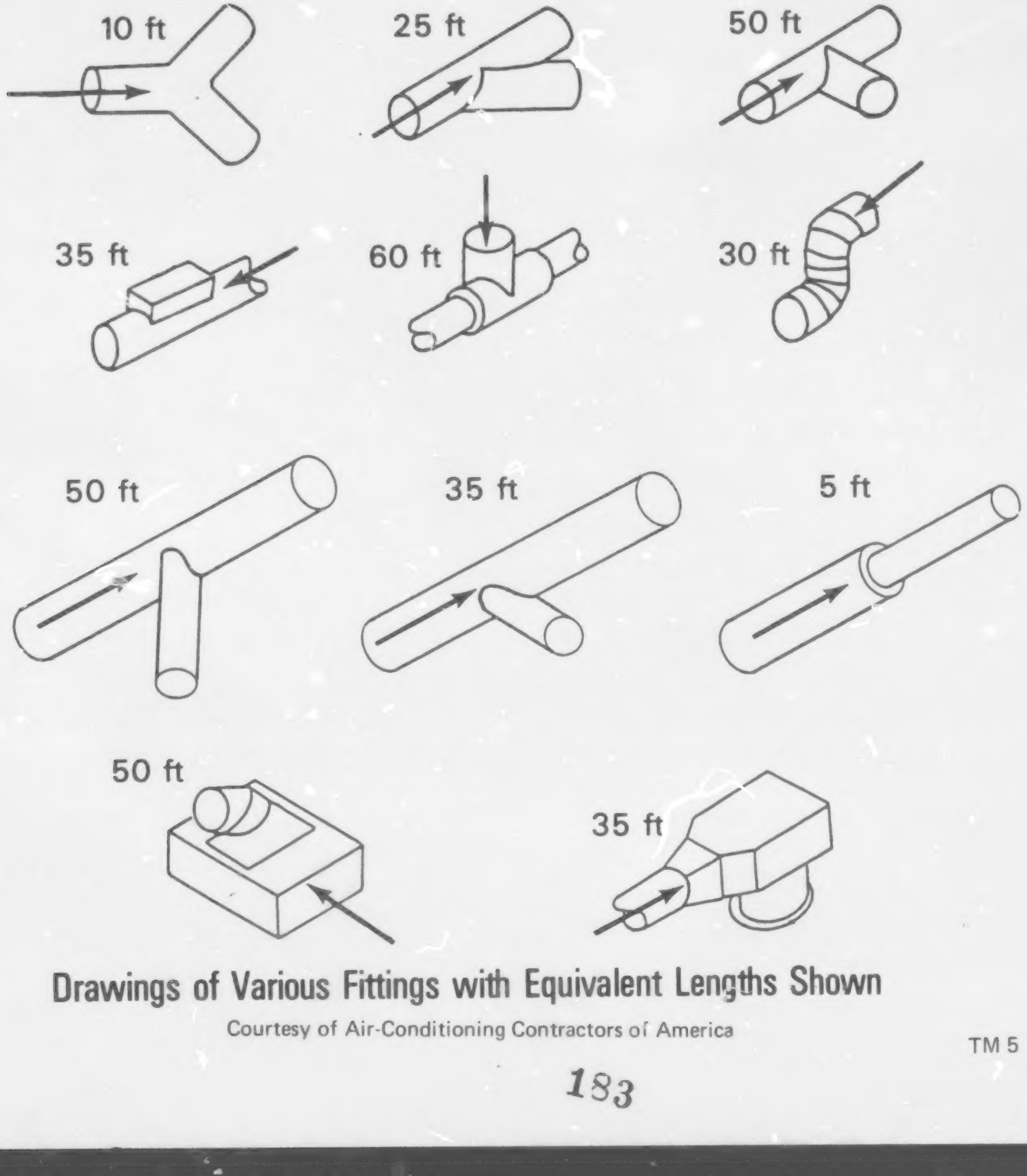
Courtesy of Air-Conditioning Contractors of America

Duct Fittings and Equivalent Lengths

(Group 4)

Round Trunk Duct Fittings

(Add 25 equivalent feet to Each
of the 3 fittings nearest the Unit in Each Truck Duct)



Drawings of Various Fittings with Equivalent Lengths Shown

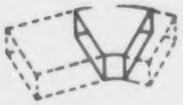
Courtesy of Air-Conditioning Contractors of America

Duct Fittings and Equivalent Lengths

(Group 5)

Angles and Elbows For Trunk Ducts

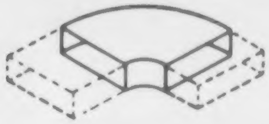
(Inside Radius=½ Width of Duct)



Trunk Width Inches

A

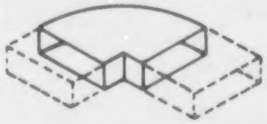
4 to 15=5 ft
16 to 27=10 ft
28 to 41=15 ft
42 to 52=20 ft
53 to 64=25 ft



Trunk Width Inches

B

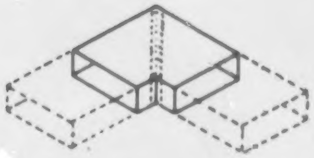
4 to 11=10 ft
12 to 21=15 ft
22 to 27=20 ft
28 to 33=25 ft
34 to 42=30 ft
43 to 51=40 ft
52 to 64=50 ft



Trunk Width Inches

C

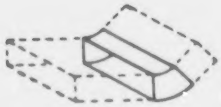
4 to 6=20 ft
7 to 11=40 ft
12 to 15=55 ft
16 to 21=75 ft
22 to 27=100 ft
28 to 33=125 ft
34 to 42=150 ft



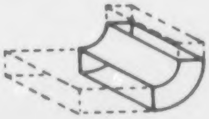
Trunk Width Inches

D

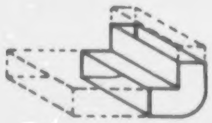
4 to 11=15 ft
12 to 21=20 ft
22 to 27=25 ft
28 to 42=40 ft



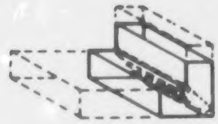
E=5 ft



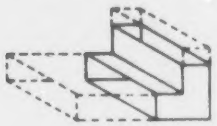
F=10 ft



G= 30 ft



H=15 ft



I=30 ft

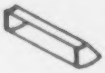
Courtesy of Air-Conditioning Contractors of America

Duct Fittings and Equivalent Lengths

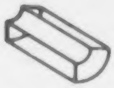
(Group 6)

Angles and Elbows For Individual and Branch Ducts

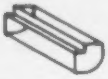
Inside Radius for "A" and "B"= 3 in.
and for "F" and "G " = 5 in.



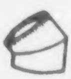
A=5 ft



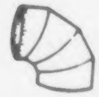
B=10 ft



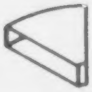
C=25 ft



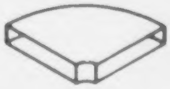
D=5 ft



E=10 ft

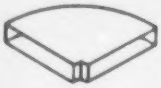


F=5 ft



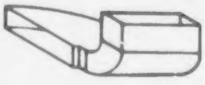
G

10 in. wide=10 ft
12 =15 ft
14 =15 ft



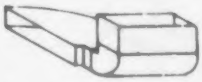
H

10 in. wide=40 ft
12 =55 ft
14 =55 ft



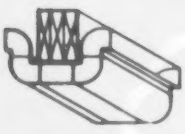
I

3¼ x 10 in.=60 ft
12 =75 ft
14 =75 ft

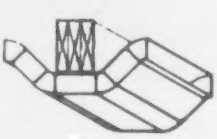


J

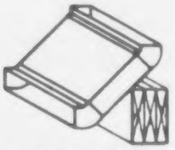
3¼ x 10 in.=75 ft
12 =90 ft
14 =90 ft



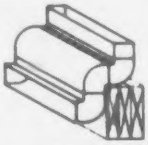
K=125 ft



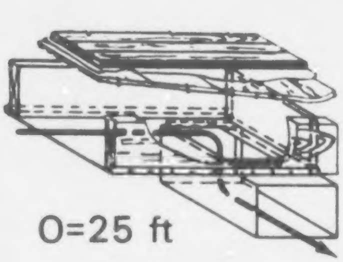
L=35 ft



M=10 ft

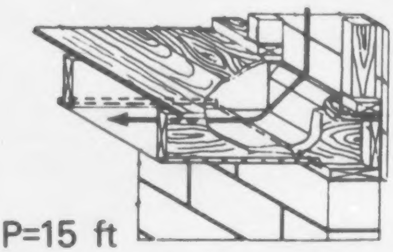


N=95 ft



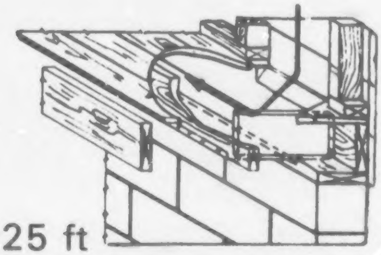
O=25 ft

Return Air Liner To Duct



P=15 ft

Stud Spacer to Liner



Q=25 ft

Stud Spacer To Liner

Drawings of Various Fittings with Equivalent Lengths Shown

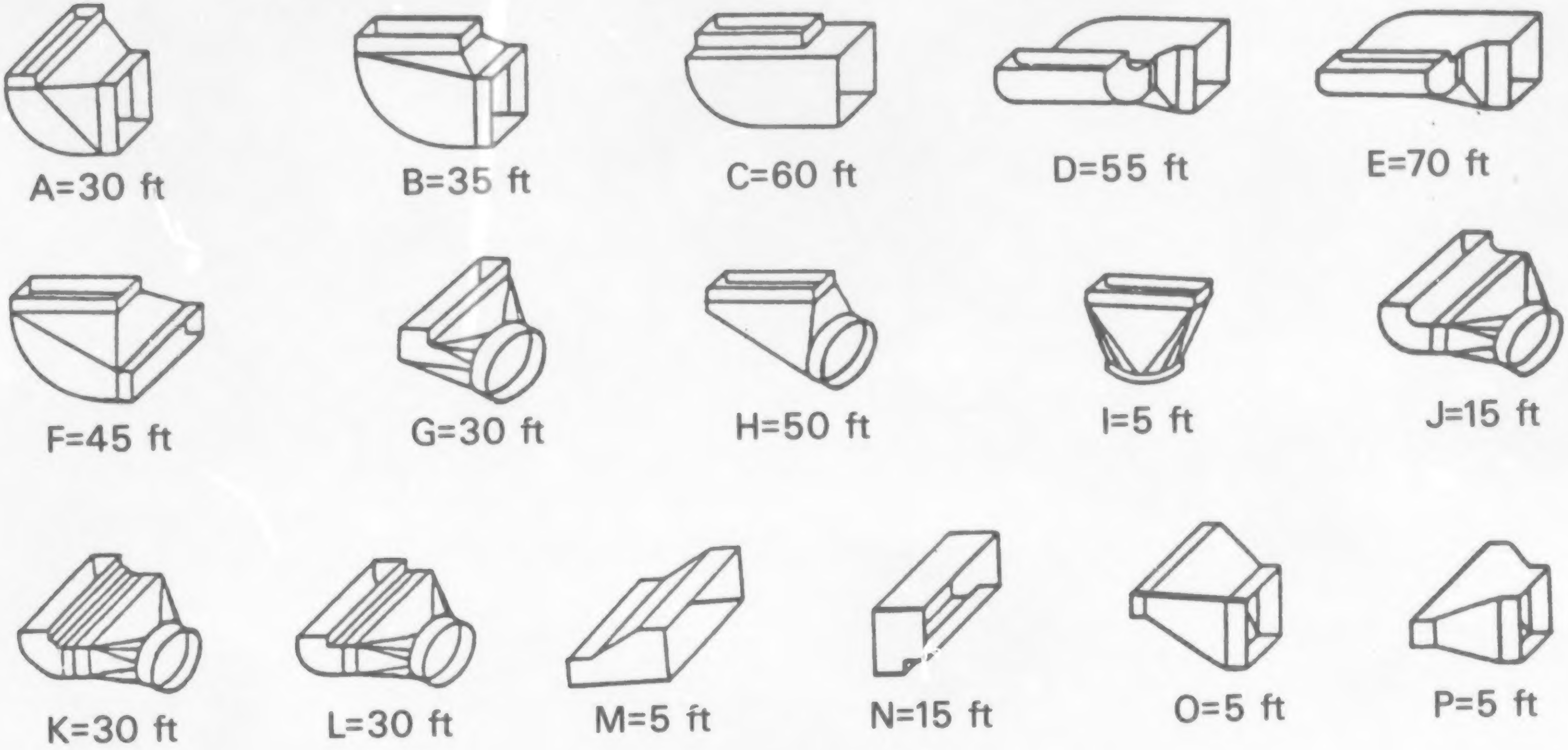
Courtesy of Air-Conditioning Contractors of America

Duct Fittings and Equivalent Lengths

(Group 7)

Boot Fittings

(These Values may also be Used for Floor Diffuser Boxes)



A=30 ft B=35 ft C=60 ft D=55 ft E=70 ft

F=45 ft G=30 ft H=50 ft I=5 ft J=15 ft

K=30 ft L=30 ft M=5 ft N=15 ft O=5 ft P=5 ft

Drawings of Various Fittings with Equivalent Lengths Shown

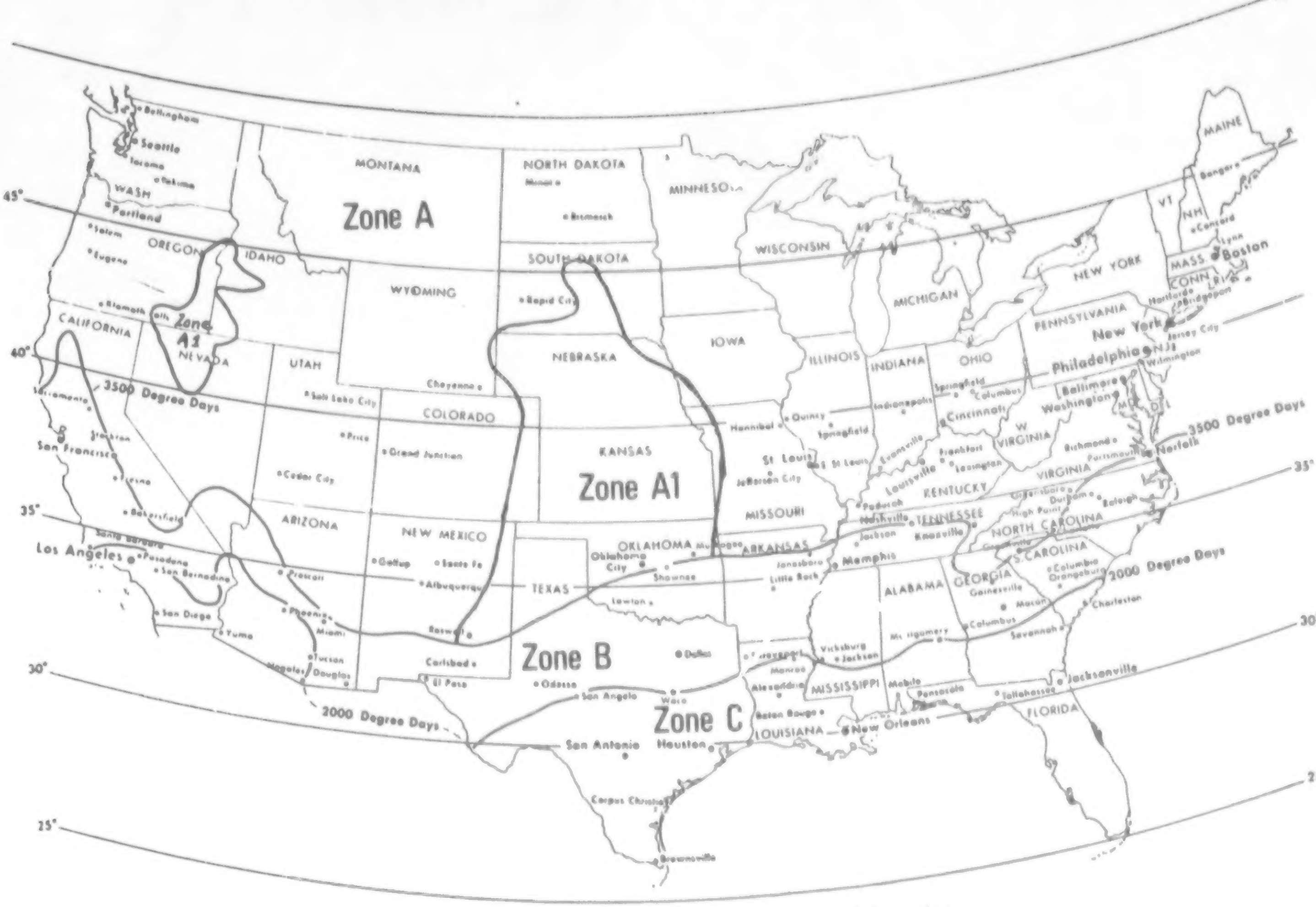
Courtesy of Air-Conditioning Contractors of America

Rectangular Duct Equivalents

Duct Diameter, in.	Equivalent Rectangular Stack and Duct Sizes, in.												
4.0		4.5x3											
4.5	8x2.25	6x3											
5.0	10x2.25		8x3.25	5x4	4x5			3x8					
5.5	12x2.25		10x3.25	7x4	5x5			4x8					
6.0	14x2.25		10x3.25	8x4	6x5			4x8					
6.5			12x3.25	9x4	7x5	6x6		5x8					
7.0			14x3.25	11x4	8x5	7x6		5x8					
7.5				13x4	10x5	8x6	7x7	6x8					
8.0				15x4	11x5	9x6	8x7	7x8					
8.5				17x4	13x5	10x6	9x7	8x8					
9.0				20x4	15x5	12x6	10x7	8x8					
9.5				22x4	17x5	13x6	11x7	9x8	8x9				
10.0				25x4	19x5	15x6	12x7	11x8	9x9				
10.5					21x5	16x6	14x7	12x8	10x9	9x10			
11.0					23x5	18x6	15x7	13x8	11x9	10x10			
11.5					26x5	20x6	17x7	14x8	12x9	11x10			
12.0					29x5	22x6	18x7	16x8	14x9	12x10			
12.5					32x5	24x6	20x7	17x8	15x9	13x10	11x12		
13.0					35x5	27x6	22x7	18x8	16x9	14x10	12x12		
13.5						30x6	24x7	20x8	17x9	16x10	13x12		
14.0						32x6	26x7	22x8	19x9	17x10	14x12		
14.5						35x6	28x7	24x8	20x9	18x10	15x12		
15.0						38x6	31x7	26x8	22x9	19x10	16x12	14x14	
15.5						41x6	33x7	28x8	24x9	21x10	17x12	14x14	
16.0						45x6	36x7	30x8	25x9	22x10	18x12	15x14	
16.5							38x7	32x8	27x9	24x10	19x12	16x14	
17.0							41x7	34x8	29x9	25x10	21x12	17x14	15x16
17.5							44x7	37x8	31x9	27x10	22x12	18x14	16x16
18.0								39x8	33x9	29x10	23x12	20x14	17x16
18.5								42x8	36x9	31x10	25x12	21x14	18x16
19.0								45x8	38x9	33x10	26x12	22x14	19x16
19.5								47x8	41x9	35x10	28x12	23x14	20x16
20.0								51x8	43x9	37x10	29x12	25x14	21x16

Courtesy of Air-Conditioning Contractors of America

Climatic Zone Map for System Selection



Courtesy of Air-Conditioning Contractors of America

Friction Loss Per 100 Feet Chart

Effective Length Of Duct (Ft.)	TOTAL PRESSURE DROP IN DUCT (IN. OF WATER)								
	0.05	0.07	0.10	0.15	0.20	0.25	0.30	0.40	0.50
35-44	0.13	0.18	0.25	0.38	0.50	0.63	0.75	1.00	1.25
45-54	0.10	0.14	0.20	0.30	0.40	0.50	0.60	0.80	1.00
55-64	0.08	0.12	0.17	0.25	0.33	0.42	0.50	0.67	0.83
65-74	0.07	0.10	0.14	0.21	0.29	0.36	0.43	0.57	0.72
75-84	0.06	0.09	0.13	0.19	0.25	0.31	0.38	0.50	0.63
85-94	0.06	0.08	0.11	0.17	0.22	0.28	0.33	0.45	0.56
95-104	0.05	0.07	0.10	0.15	0.20	0.25	0.30	0.40	0.50
105-114	0.05	0.06	0.09	0.14	0.18	0.23	0.28	0.37	0.46
115-129	0.04	0.06	0.08	0.12	0.17	0.21	0.25	0.33	0.47
130-149	0.04	0.05	0.07	0.11	0.14	0.18	0.21	0.29	0.36
150-169	0.03	0.04	0.06	0.09	0.13	0.16	0.19	0.25	0.31
170-189	0.03	0.04	0.06	0.08	0.11	0.14	0.17	0.22	0.28
190-214	0.03	0.04	0.05	0.08	0.10	0.13	0.15	0.20	0.25
215-239	0.02	0.03	0.05	0.07	0.09	0.11	0.13	0.18	0.22
240-264	0.02	0.03	0.04	0.06	0.08	0.10	0.12	0.16	0.20
265-289	0.02	0.03	0.04	0.05	0.07	0.09	0.11	0.15	0.18
290-324	0.02	0.03	0.03	0.05	0.07	0.08	0.10	0.13	0.17
325-374	0.02	0.02	0.03	0.04	0.06	0.07	0.09	0.11	0.14
375-424	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.10	0.13
425-474	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.09	0.11
475-524	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.10
525-574	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.09
575-625	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.07	0.08

Table for converting system design pressure (total pressure drop in duct) and total effective length of duct to friction loss per 100 ft.

Courtesy of Air-Conditioning Contractors of America

Suggested Static Pressures for Duct Design

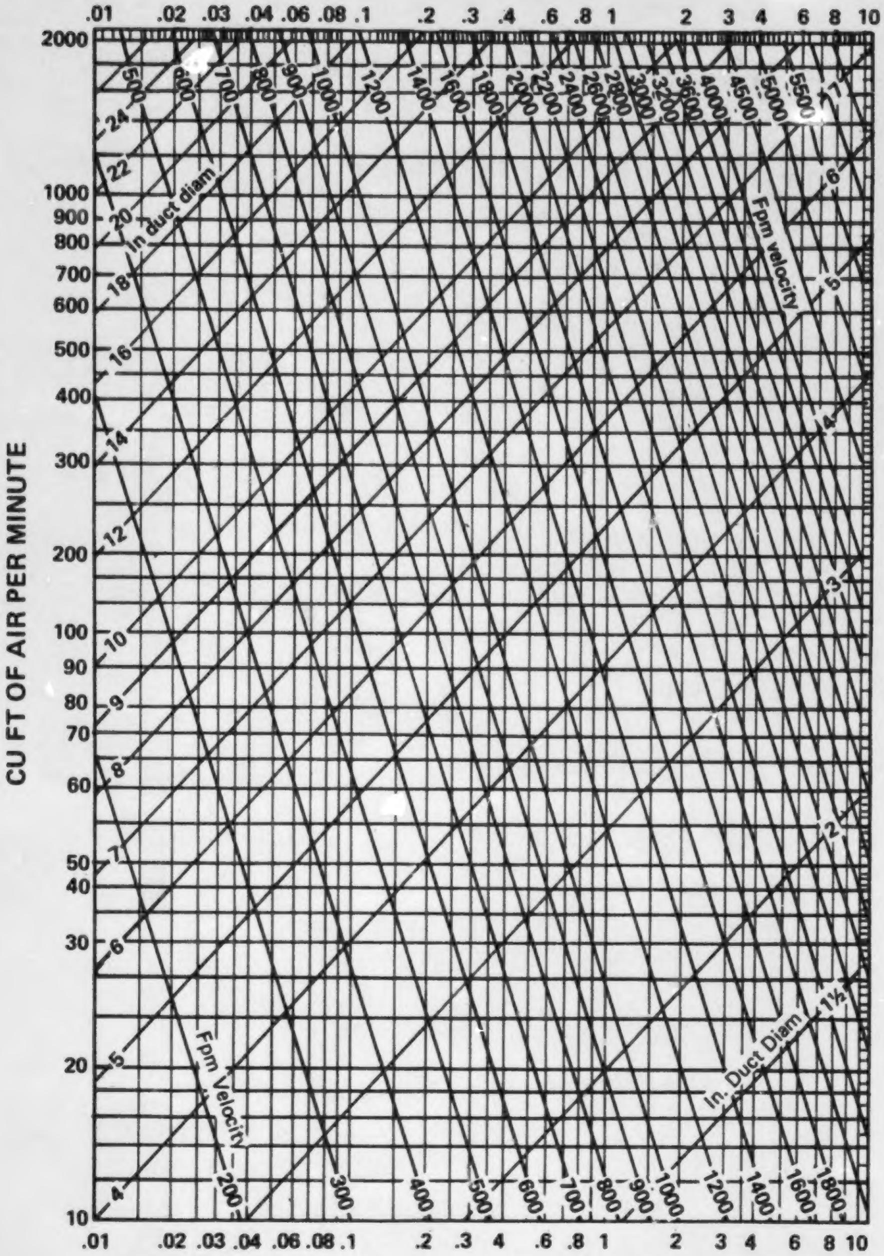
Available External Pressure (in W.G.)	.12	.15	.20	.25	.30	.40
Use for Supply	.07	.10	(*.15) .10	.15	.20	.30
Multiple Return	.05	.05	.10	.10	.10	.10
Simple Return	.05	.05	.05	.10	.10	.10

*Simple Return

Pressures included in this Table are suggested for most typical installations. Other pressures may be used when desired. Be certain that duct system pressure plus pressure loss of cooling coil, all accessories, etc., do not exceed the available static pressure of unit selected.

Courtesy of Air-Conditioning Contractors of America

Friction Chart



Friction Loss in Inches of Water Per 100 Ft

(Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean round, galvanized metal ducts having approximately 40 joints per 100 ft.)

Caution: Do not extrapolate below chart.

Courtesy of Air-Conditioning Contractors of America

DUCT DESIGN AND SIZING
UNIT VII

ASSIGNMENT SHEET #1--SOLVE PROBLEMS USING THE FRICTION LOSS PER 100 FEET CHART

Directions: Using the friction loss per 100 ft. chart (Transparency 11) select the friction loss per 100 ft. of effective length when given the effective length and the pressure drop.

	Effective Length	Pressure Drop	Friction Loss per 100 ft.
1.	180	.2	
2.	125	.2	
3.	220	.2	
4.	45	.2	
5.	440	.2	
6.	350	.4	
7.	220	.25	
8.	140	.15	
9.	90	.10	
10.	500	.5	
11.	400	.4	
12.	300	.3	
13.	200	.2	
14.	100	.1	
15.	100	.2	
16.	100	.3	
17.	100	.4	
18.	100	.5	

DUCT DESIGN AND SIZING
UNIT VII

ASSIGNMENT SHEET #2--SOLVE PROBLEMS USING THE FRICTION CHART

Directions: Find duct size and velocity of air in ducts using the friction chart. (Transparency 13)

	CFM	Friction Loss per 100 ft	Duct Diameter	Velocity Ft/Min
1.	98	.02	______	______
2.	210	.03	______	______
3.	125	.08	______	______
4.	400	.20	______	______
5.	500	.20	______	______
6.	55	.07	______	______
7.	80	.15	______	______
8.	500	5.00	______	______
9.	100	.6	______	______
10.	1400	.015	______	______
11.	1000	.02	______	______
12.	500	.03	______	______
13.	200	.05	______	______
14.	2000	3.5	______	______

DUCT DESIGN AND SIZING
UNIT VII

ASSIGNMENT SHEET #3--DESIGN AN AIR DISTRIBUTION SYSTEM FROM A DRAWING

A. Make a single line scale drawing of the desired supply and return duct system (Figures 1 and 2)

B. Select adequate heating and/or cooling equipment from Manufacturer's catalog

(NOTE: The output capacity of the equipment must conform to local codes.)

C. Determine total available external static pressure and cfm of equipment blower from equipment nameplate or manufacturer's literature

Examples: External s.p. .05 i.w.g. expressed on nameplate
Cfm 1200 @ .03 i.w.g. expressed in literature

D. Apportion pressure drop to supply and return duct systems (TM 12)

E. Determine cfm per Btuh Heating

Example: $\frac{800 \text{ cfm}}{80{,}000 \text{ Btuh Output}} = .01$ cfm/Btuh

F. Determine temperature rise

Example: Furnace output in Btuh divided by cfm X 1.1

$\frac{80{,}000}{800 \times 1.1} = 90.9$ degrees temperature rise

(NOTE: In psychrometric calculations the factor 1.08 has been used for many years. ASHRAE has recently recommended that this factor be changed to 1.1.)

G. Determine cfm per Btuh cooling

(NOTE: System design in cooling is nearly always 400 cfm per 12,000 btuh cooling, therefore the cfm per Btuh will consistently be .033.)

H. Multiply each room heat loss by cfm per Btuh heating to determine cfm per room, heating

I. Multiply each room heat gain by cfm per Btuh cooling to determine cfm per room, cooling

J. Select the larger cfm as the minimum air volume for each room

K. Determine number of outlets for each room and apportion cfm to each outlet if more than one is required (Figure 3)

ASSIGNMENT SHEET #3

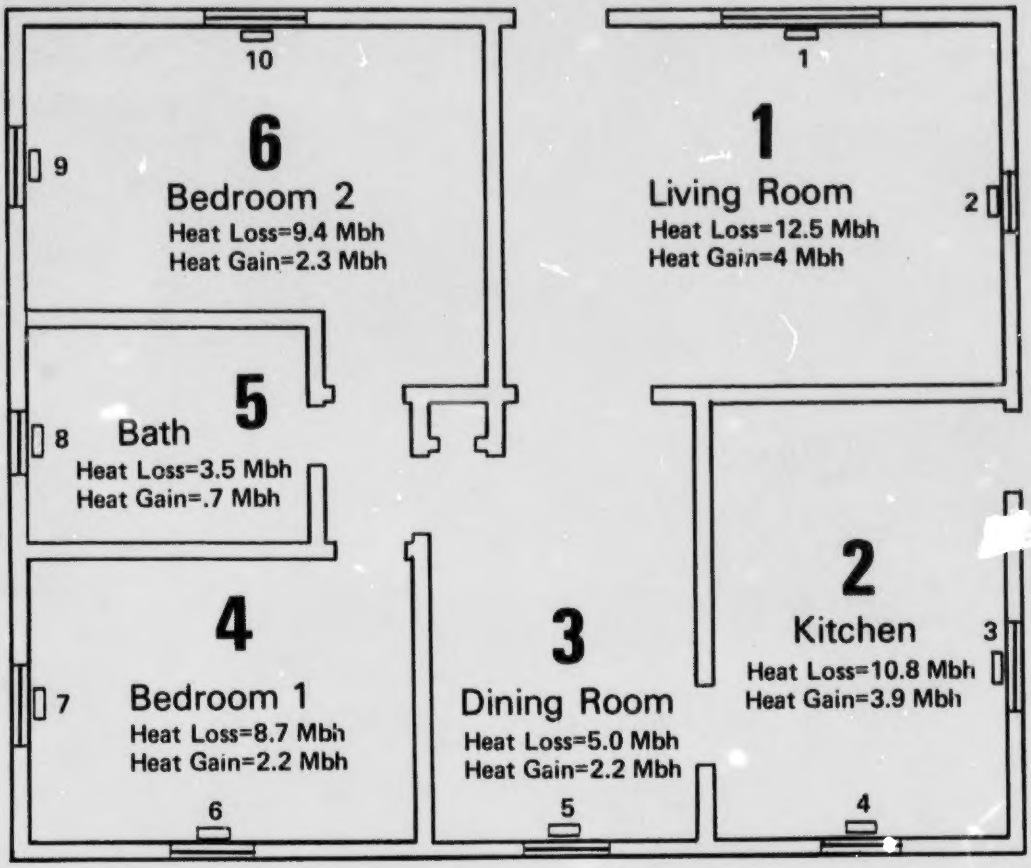


FIGURE 1

(Courtesy of Air-Conditioning Contractors of America)

ASSIGNMENT SHEET #3

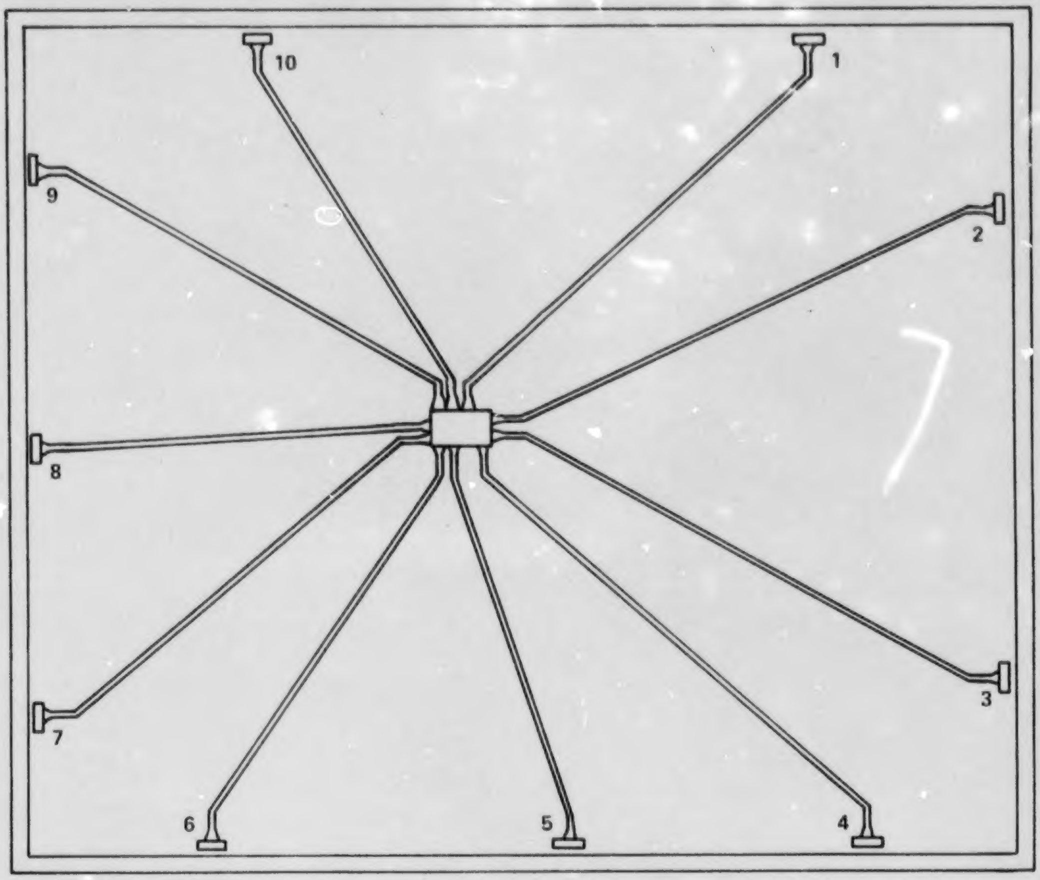


FIGURE 2

(Courtesy of Air-Conditioning Contractors of America)

ASSIGNMENT SHEET #3

Recommended Maximum Air Volumes for Common Sizes of Residential Type Registers and Diffusers

ROUND DUCT DIAMETER	HIGH OR LOW WALL REGISTER	FLOOR DIFFUSER	ROUND CEILING DIFFUSER	RECOMM. MAXIMUM CFM
6"	10" X 6"	10" X 4"	6"	100 - 110 CFM
7"	12" X 6"	12" X 4"	7"	150 - 160 CFM
8"	14" X 6"	14" X 4"	8"	200 - 215 CFM

FIGURE 3

L. Measure actual length of each duct from scale drawing

M. List duct fittings and equivalent lengths of fittings (Transparencies 3, 4, 5, 6, 7, 8, and 9)

  1. Do not include register or grille

  2. Use plenum fitting for all ducts which take off at plenum

  3. Add equivalent lengths in each duct and record

N. Add measured length to equivalent length and record total effective length of each duct

O. Using proper pressure drop from step D select friction loss per 100 ft. for each duct (Transparency 11)

P. Select diameter of round duct and velocity for each duct from friction chart (Transparency 13)

Q. Repeat steps K through P for return duct system using return air pressure drop from step D

ASSIGNMENT SHEET #3

R. Determine rectangular duct or wall stack if required (Transparency 9)

S. Determine required registers and grilles

1. Use manufacturer's catalog sheets
2. Static pressure of registers and grilles are not to exceed .03 i.w.g.

SPECIFICATIONS:

Outside design temperature: 10 degrees

Daily temperature range: Medium

Ducts located in ventilated crawl space

Duct insulation: 1" flexible duct wrap

Total Heat Loss: 49,900 Btuh

Total Heat Gain: 17,600 Btuh

Equipment selected: 60,000 Btuh Input Gas Furnace
18,000 Btuh Air Conditioner

Equipment Blower: 600 cfm at .15 static pressure

Return air system: Simple Return

ASSIGNMENT SHEET #3

Specifications:
Equivalent Length of Fittings

1		2		3		4		5	
FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.
1-E		1-E		1-E		1-E		1-E	
6-D		6-D		6-D		6-D		6-D	
6-E		6-E		6-E		6-E		6-E	
7-I		7-I		7-I		7-I		7-I	
Total		Total		Total		Total		Total	

6		7		8		9		10	
FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.
1-E		1-E		1-E		1-E		1-E	
6-D		6-D		6-E		6-E		6-D	
6-E		6-E		7-G		6-E		6-E	
7-I		7-G		7-N		6-E		7-I	
		7-N				6-E			
						7-G			
						7-N			
Total		Total		Total		Total		Total	

(NOTE: All references to fittings are by group number and item number. 1-E means item E from group 1, 6-D means item D from group 6, etc. Check the appropriate transparency masters before making calculations.)

ASSIGNMENT SHEET #3

JOB NAME ASSIGNMENT SHEET #3

SUPPLY STATIC PRESSURE ______ IWG

CFM PER BTU HEATING ________

DATE Complete this form

RETURN STATIC PRESSURE ______ IWG

CFM PER BTU COOLING .033

FURNACE OUTPUT 48000

BLOWER CFM 600

TOTAL EXTERNAL STATIC PRESS .151 IWG

Temp. Rise ____________

Room	Heat Loss	CFM Htng	Heat Gain	CFM Cooling	Outlet #	CFM	Meas. Length	Equiv. Length	Eff. Length	Press. Drop per 100 ft.	Duct Diameter	Velocity
Living	12,500		4,000		1		15					
"					2		20					
Kitchen	10,800		3,900		3		25					
"					4		15					
Dining	5,000		2,200		5		12					
Bedroom #1	8,700		2,200		6		15					
"					7		20					
Bath	3,500		700		8		8					
Bedroom #2	9,400		2,300		9		25					
"					10		10					

DUCT DESIGN AND SIZING
UNIT VII

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. .11
2. .17
3. .09
4. .40
5. .05
6. .11
7. .11
8. .11
9. .11
10. .10
11. .1
12. .1
13. .1
14. .1
15. .2
16. .3
17. .4
18. .5

Assignment Sheet #2

1.	8	275
2.	10	400
3.	7	500
4.	9	1000
5.	10	1100
6.	5	400
7.	5	600
8.	5	4000
9.	5	1100
10.	24	450
11.	20	500
12.	14	500
13.	9	475
14.	9	4500

Assignment Sheet #3

Specifications:
Equivalent Length of Fittings

1		2		3		4		5	
FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.
1-E	35	1-E	35	1-E	35	1-E	35	1-E	35
6-D	5	6-D	5	6-D	5	6-D	5	6-D	5
6-E	10	6-E	10	6-E	10	6-E	10	6-E	10
7-I	5	7-I	5	7-I	5	7-I	5	7-I	5
Total	55	Total	55	Total	55	Total	55	Total	55

6		7		8		9		10	
FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.	FTG.	E.L.
1-E	35	1-E	35	1-E	35	1-E	35	1-E	35
6-D	5	6-D	5	6-E	10	6-E	10	6-D	5
6-E	10	6-E	10	7-G	30	6-E	10	6-E	10
7-I	5	7-G	30	7-N	15	6-E	10	7-I	5
		7-N	15			6-E	10		
						7-G	30		
						7-N	15		
Total	55	Total	95	Total	85	Total	120	Total	55

Assignment Sheet #3

SUPPLY STATIC PRESSURE .10 IWG   CFM PER BTU HEATING .0125

DATE Complete this form   RETURN STATIC PRESSURE .05 IWG   CFM PER BTU COOLING .033

FURNACE OUTPUT 48000   BLOWER CFM 600   TOTAL EXTERNAL STATIC PRESS .151IWG   Temp. Rise 73°

Room	Heat Loss	CFM Htng	Heat Gain	CFM Cooling	Outlet #	CFM	Meas. Length	Equiv. Length	Eff. Length	Press. Drop per 100 ft.	Duct Diameter	Velocity
Living	12,500	156	4,000	132	1	78	15	55	70	.14	5	600
"					2	78	20	55	75	.13	5	550
Kitchen	10,800	135	3,900	129	3	68	25	55	80	.13	5	550
"					4	68	15	55	70	.14	5	550
Dining	5,000	63	2,200	73	5	73	12	55	67	.14	5	600
Bedroom #1	8,700	108	2,200	73	6	54	15	55	70	.14	5	550
"					7	54	20	95	100	.10	5	550
Bath	3,500	44	700	23	8	44	8	85	93	.11	5	450
Bedroom #2	9,400	117	2,300	76	9	59	25	120	145	.07	6	300
"					10	59	10	55	65	.14	5	450

DUCT DESIGN AND SIZING
UNIT VII

JOB SHEET #1--DETERMINE THE PRESSURE DROP ACROSS AN EVAPORATOR COIL

I. Tools and equipment

A. Manometer

B. Drill

C. Duct tape

D. Forced air system as selected by instructor

II. Procedure

A. Drill into the return air duct a hole just large enough to insert one end of the hose on the manometer

B. Drill into the supply air duct a hole just large enough to insert one end of the hose on the manometer

C. Place one end of the manometer hose in the hole in the return air duct and leave the other end open to atmosphere

D. Read and record the static pressure

E. Place one end of the manometer hose in the hole in the supply air duct and leave the other end open to atomsphere

F. Read and record the static pressure

G. Determine total pressure drop across the evaporator coil

H. Discuss your findings with your instructor

I. Patch holes in ducts with duct tape and return manometer to proper storage area

DUCT DESIGN AND SIZING
UNIT VII

JOB SHEET #2–DETERMINE THE CFM BEING DELIVERED BY A GIVEN FORCED AIR SYSTEM

I. Tools and equipment

   A. Velometer or anemometer

   B. Forced air system as selected by instructor

II. Procedure

   A. Take a velocity reading at the face of all supply air registers with the velometer or anemometer

   B. Record the readings

   C. Take a velocity reading at the face of the return air grille or grilles with the velometer or anemometer

   D. Record the readings

   E. Compare the recorded readings to determine if the forced air system is producing the design air quantities in CFM

   F. Discuss your findings with your instructor

   G. Return velometer or anemometer to proper storage area

DUCT DESIGN AND SIZING
UNIT VII

NAME ______________________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. Heating or cooling equipment which incorporates its own air distribution system as part of its design

_____b. The measure of the resistance of ducts, grilles, filters, and other surfaces to the flow of air

_____c. A box-like fitting into which an air handler discharges air or from which the air handler receives return air in a duct system

_____d. Tube or channel through which air is conveyed or moved

_____e. A duct fitting which adapts the duct to a wall stack or to a register or grille

_____f. The point of departure from a duct to which a duct fitting is attached to accomplish branching of ductwork

_____g. Resistance to air flow created by the structural design of a fitting, indicated by the length of straight duct which would offer the same resistance

_____h. The sum of the measured length of straight duct plus the equivalent lengths of fittings in the duct

_____i. The physical measurement of a duct

_____j. Device used to control the volume of air flow passing through or out of a duct or register

_____k. A fixed or adjustable device used to direct air flow

_____l. A louvered opening usually found in a return air opening

1. Take-off
2. Temperature gradient
3. Register
4. Floor warming
5. Actual measured length
6. Entrained air
7. Convection currents
8. Proprietary system
9. Wall stack
10. Grille
11. Primary air
12. Duct

______m. A grille that has a regulating damper device for controlling amount of air flow and vanes to control air direction

______n. A register which delivers fan shaped patterns of air into a room

______o. A method of duct design used to meter air flow so that air is distributed proportionately to all conditioned spaces

______p. The sum of the negative and positive static pressures being exerted by a blower

______q. Air currents set in motion by cooling or warming of air brought in contact with hot or cold surfaces such as walls or windows

______r. Condition in which there is little or no air movement in room; air lies in temperature layers

______s. Temperature change from one level or stratum to the next as in the change from floor to ceiling

______t. The transfer of large masses of air due to convection currents in a structure often caused by warm air rising and cooler air falling through building accesses such as stairs

______u. A thin, rectangular duct which runs vertically inside a wall

______v. A peculiar ability of moving air to cling to a ceiling or a wall

______w. Feet per minute, a measurement of velocity

______x. An arbitrary maximum velocity of an air stream which spreads or drops into a living area, usually considered comfortable at 35-50 fpm

______y. The distance a high sidewall supply outlet delivers air before slowing to terminal velocity

______z. The distance air falls vertically below a high sidewall supply outlet before slowing to terminal velocity

13. fpm
14. Equal friction method
15. Static pressure
16. Effective length
17. Cascade effect
18. Vane
19. Spread
20. Pressure drop
21. Ceiling or wall effect
22. Plenum
23. System pressure
24. Drop
25. Damper
26. Throw

_____aa. The fan-like width of an air stream from a diffusing type supply outlet at the point of terminal velocity

_____bb. A mixture of supply air from an outlet and room air at velocities above 150 fpm

_____cc. Room air which is dragged into the primary air and raised to higher velocities inside the primary air envelope

_____dd. Floor heating by burying ducts in concrete slab floors or by running supply ducts under floors

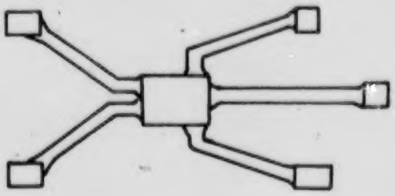
_____ee. Net area of a register or grille after subtracting areas of vanes or dampers, typically 70% of gross face area or as specified by manufacturer

_____ff. The phenomenon of static pressure diminishing from maximum at the blower to zero after passing through an outlet regardless of duct length

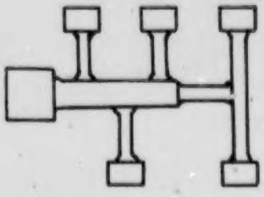
_____gg. Inches water gauge

27. Equivalent length
28. Free area
29. Terminal velocity
30. Boot
31. Diffuser
32. Stratification of air
33. IWG

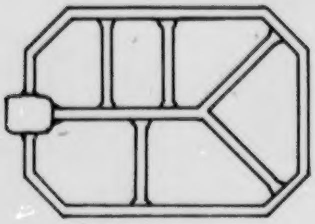
2. Identify the types of supply duct systems.



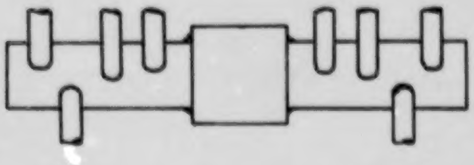
a. ______________________________



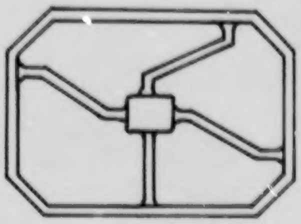
b. ______________________________



c. ______________________________



d. ______________________________



e. ______________________________

3. Match the factors affecting system design on the right with the effects they have on the system.

_____a. 1) Volume--Greater duct length reduces volume of air to be delivered

2) Pressure--Greater duct length increases static pressure and resistance to air flow

3) Duct gain or loss--Greater duct length increases temperature of cold air or reduces temperature of warm air passing through the duct

_____b. Changes in shape or direction of ducts will reduce volume of air flow because of increased resistance caused by air flow friction

_____c. 1) Prime factor used to determine duct diameter for a given pressure in the system

2) Determined by adding the actual duct work length plus the equivalent length of fittings

1. Effective length
2. Temperature rise
3. Design air volume

_____ d. 1) Prime factor used to determine duct diameter for a given air volume in a system

2) Selection is made after determining capability of equipment blower

3) Apportioned between supply ducts and return ducts

_____ e. 1) Transmits the total heat available from the heat source proportional to the amount of air delivered

2) When heating, the temperature will rise if the amount of air is reduced, and the temperature will fall if the amount of air is increased

_____ f. Affects the selection of the duct diameter; if the factor is too small, the duct diameter will be too large

_____ g. 1) A decrease in air volume will result in an increase in temperature rise

2) An increase in air volume will result in a decrease in temperature rise

_____ h. Reduces heat loss or heat gain in duct and eliminates condensation

_____ i. Size, design, and location affect the efficiency of the system and degree of comfort

4. Duct wrap
5. Duct length
6. System pressure
7. Supply outlets
8. Equivalent length
9. Pressure drop per 100 ft.

4. Match the major steps in air system design on the right to the procedures to follow in completing each step.

_____ a. 1) Calculate total system load

2) Calculate heating and cooling CFM

3) Determine appropriate type of equipment to be used

4) Select proper sized unit for heating

5) Select condensing unit and evaporator coil for cooling

6) Determine location of condensing unit, heating equipment, and thermostat

1. Select registers and grilles for supply and return air
2. Lay out and size duct work
3. Select heating and cooling equipment
4. Select air distribution system

_____b. 1) Examine floor plan to determine appropriate outlet register

2) Select appropriate registers based on correct distribution patterns

3) Select the proper return air grille size

_____c. 1) Determine climatic region

2) Determine design of structure

3) Determine location of ducts

4) Determine best type of distribution system

_____d. 1) Determine appropriate location of duct work

2) Calculate number of outlet and inlet openings

3) Calculate the CFM required for each outlet

4) Determine the type of duct to be used and draw the runs

5) Obtain the equivalent lengths of fittings

6) Determine the total effective length of ducts

7) Determine the external static pressure drop per 100 ft.

8) Size duct using appropriate charts

5. Select factors affecting return air duct design by placing an "X" in the appropriate blanks.

_____a. Return air inlets are normally placed within 60 feet of a supply

_____b. Return air inlets should be placed on every level of a split level residence

_____c. Return air inlets are not normally placed in a kitchen or a bathroom

_____d. Return air inlets are normally placed so that air is not dragged over 30 feet from a supply

_____e. Return air duct systems must be designed for a design air volume equal to or greater than the supply air volume

_____ f. Return air duct systems must be designed for a design air volume equal to or less than the supply air volume

_____ g. Place a return air inlet on only the upper level of a split level residence

_____ h. An optimum system has a return air inlet in each bedroom

_____ i. Return air inlets are usually placed on inside walls which allows shorter duct work

6. List four locations of registers and grilles.

   a.

   b.

   c.

   d.

7. List one advantage and one disadvantage for each location of registers and grilles.

   a. 1) Advantage--
      2) Disadvantage--

   b. 1) Advantage--
      2) Disadvantage--

   c. 1) Advantage--
      2) Disadvantage--

   d. 1) Advantage--
      2) Disadvantage--

8. Describe four climatic zone conditions.

   a. Zone A--

   b. Zone B--

   c. Zone C--

   d. Zone A1--

9. Name four factors to consider in the distribution of conditio.

a.

b.

c.

d.

10. Match the recommended velocities on the right to the outlet placement on the left.

_____a. Floor diffusers	1. 700 fpm
_____b. Baseboard diffusers	2. 350-500 fpm
_____c. High sidewall registers	3. 500 fpm
_____d. Low sidewall registers	4. 450 fpm

11. Solve problems using the friction loss per 100 feet chart.

12. Solve problems using the friction chart.

13. Design an air distribution system from a drawing.

14. Demonstrate the ability to:

   a. Determine the pressure drop across an evaporator coil.

   b. Determine the CFM being delivered by a given forced air system.

   (NOTE: If these items have not been completed prior to the test, ask your instructor when they should be completed.)

DUCT DESIGN AND SIZING
UNIT VII

ANSWERS TO TEST

1. a. 8
   b. 15
   c. 22
   d. 12
   e. 30
   f. 1
   g. 27
   h. 16
   i. 5
   j. 25
   k. 18
   l. 10
   m. 3
   n. 31
   o. 14
   p. 23
   q. 7
   r. 32
   s. 2
   t. 17
   u. 9
   v. 21
   w. 13
   x. 29
   y. 26
   z. 24
   aa. 19
   bb. 11
   cc. 6
   dd. 4
   ee. 28
   ff. 20
   gg. 33

2. a. Radial or spider
   b. Trunk and branch reducing plenum
   c. Perimeter loop trunk duct
   d. Trunk and branch extended plenum
   e. Perimeter loop radial duct

3. a. 5
   b. 8
   c. 1
   d. 6
   e. 3
   f. 9
   g. 2
   h. 4
   i. 7

4. a. 3
   b. 1
   c. 4
   d. 2

5. b, c, d, e, h, i

6. a. Perimeter
   b. High inside wall
   c. Low inside wall
   d. Ceiling

7. Any one advantage and disadvantage under each location for registers and grilles

   a. Perimeter system
      1) Advantages
         a) Delivers conditioned air at point of greatest heat loss and heat gain, which is the outside of the structure
         b) Allows fewer air returns which are generally located in inner areas of structure
         c) Delivers the highest level of comfort of any system
      2) Disadvantages
         a) More costly than many other systems
         b) May be subject to water problems if ducts are buried under the slab

- b. High inside wall system
  - 1) Advantages
    - a) Supply outlets are located central to main trunk duct, so shorter ducts can be used
    - b) Pressure is less, so smaller blower may be used
    - c) Doesn't interfere with furniture placement
    - d) Permits longer periods of blower operation
    - e) Well suited for cooling in areas where heating is of less importance
    - f) Less costly installation
  - 2) Disadvantages
    - a) Heating is more difficult because of stratification
    - b) Areas of greatest heat loss and gain such as windows are difficult to condition unless special attention is paid to selection of registers
- c. Low inside wall system
  - 1) Advantages
    - a) Supply outlets are located close to the blower
    - b) Installation is less costly
  - 2) Disadvantages
    - a) Proper air distribution is difficult
    - b) High air velocities must be avoided
    - c) Furniture placement is difficult
    - d) Difficult to use as a cooling system
    - e) Diffuser vanes must be adjusted seasonally
- d. Ceiling
  - 1) Advantages
    - a) Doesn't interfere with furniture placement
    - b) Can be located in center of room or near outside wall
    - c) Well suited for summer cooling
    - d) Return air can be located on either inside or outside wall, near the floor
  - 2) Disadvantages
    - a) Proper selection of supply registers is critical
    - b) Doesn't heat floors directly
    - c) Can cause room air stratification and large air temperature gradients

8. Description should include:

- a. Zone A
  - 1\. Cold weather is more severe and more prolonged
  - 2\. Summers are relatively mild
- b. Zone B
  - 1\. Less severe winters than zone A
  - 2\. Hotter days for extended periods
- c. Zone C
  - 1\. Has mild winters
  - 2\. Has hot summers
- d. Zone A1--Has the characteristics of zone A except that summer temperatures are, on the average, higher than zone A

9. a. Velocity of primary air

- b. Desired temperature of room air
- c. Proper sizing and location of grilles and registers to minimize noise and discomfort from drafts

d. Velocity of air in duct system
   1) Trunk ducts--1000 fpm
   2) Branch ducts--500-750 fpm

10. a. 4
    b. 1
    c. 2
    d. 3

11. Evaluated to the satisfaction of the instructor

12. Evaluated to the satisfaction of the instructor

13. Evaluated to the satisfaction of the instructor

14. Evaluated to the satisfaction of the instructor

AIR TREATMENT
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss air contaminants and common types of filtering equipment. The student should also be able to discuss dehumidifiers and humidifiers and install filtering and humidifying equipment. This knowledge will be evidenced by correctly performing the procedures outlined on the job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to air treatment with their correct definitions.
2. Describe air contaminants which affect humans.
3. List the advantages of maintaining proper humidity in a residence.
4. Select from a list of statements those factors which affect humidity in a residence.
5. Complete a chart showing features of common types of residential filtering equipment.
6. Select true statements concerning the operation of an electronic filter.
7. Select true statements concerning operation of a dehumidifier.
8. Select true statements concerning the operation of a typical humidifier with a forced air furnace.
9. Demonstrate the ability to:
    a. Install a humidifier with low voltage controls.
    b. Install an electronic filter.

AIR TREATMENT
UNIT VIII

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and job sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and job sheets.

VI. Arrange a field trip to a local hospital or clinic so the class can see filtering equipment used in special situations.

VII. Arrange a field trip to a local industry or restaurant so the students can see filtering equipment used in special situations.

VIII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Types of Humidifiers

      2. TM 2--Electronic Air Cleaner Operation

      3. TM 3--Components of a Dehumidifier

   D. Job sheets

      1. Job Sheet #1--Install a Humidifier with Low Voltage Controls

      2. Job Sheet #2--Install an Electronic Filter

   E. Test

   F. Answers to test

II. References:

A. Weaver, Michael, and James Kirkpatrick. *Environmental Control*. New York: Harper and Row, 1974.

B. Althouse, Andrew, and Carl Turnquist and Alfred Bracciano. *Modern Refrigeration and Air Conditioning*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1975.

AIR TREATMENT
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

  A. Micron--A unit of linear measurement which is one thousandth of a millimeter

  (NOTE: Anything smaller than 10 microns is invisible to the naked eye.)

  B. Humidistat--A control for regulating humidity in conditioned air

  C. Immersion heater--An electric heating element in a water container

  D. Impingement type filter--A filter which contains matted or porous material for removing foreign particles from conditioned air

  E. Particulates--Minute particles of various solid substances in the air

  F. Aeroallergens--Airborne substances which cause allergies in humans

  G. RH--Relative humidity

  H. Ionization--Process of breaking a substance into positive and negative particles or charges

II. Air contaminants which affect humans

  A. Size

    1. Larger than 2 microns will be expelled by the lungs

    2. Smaller than 2 microns will be retained in the lungs

    (NOTE: Particles from .1 to 1 micron will usually remain in the air; 99% of all particles in the air are smaller than 1 micron.)

  B. Type

    1. Particulates

    2. Aeroallergens

III. Advantages of maintaining proper humidity in a residence (Transparency 1)

  A. Promotes health by maintaining moisture needed by mucous membranes in nasal passages

  B. Reduces static electricity in floor coverings

  C. Prolongs life of wooden furniture by preventing drying of glued joints

INFORMATION SHEET

D. Prolongs life of textiles

E. Reduces house dust

F. Prolongs life of window sills, doors, and other construction materials

(NOTE: Too much humidity can cause rotting, mold, or mildew.)

G. Promotes human comfort

IV. Factors affecting humidity in a residence

A. Outside air temperature

B. Temperature of conditioned air

C. Appliance use and food preparation

D. Number of occupants and activities

E. Plumbing and water usage

F. Type of construction

G. Quality of components

V. Features of common types of residential filtering equipment

Type	Permanent Filter	Throw-away Filter	Electronic
Initial cost	average	low	high
Filter source	Adhesive coating	Adhesive screen-like fibers	Opposing electrical charged elements and primary fiber filter
Service or maintenance	average-clean and recoat plates	simple-replace filter	average-wash elements
Operating cost	average	low	high
Effectiveness	good	average	excellent

VI. Operation of an electronic air filter (Transparency 2)

A. Return air first passes through a throw away filter to remove larger particles

B. Partially filtered air enters an ionized field

C. A wire grid with high positive voltage charges the particles in the air

INFORMATION SHEET

D. Negatively charged plates attract the particles that have been positively charged

E. The particles are held on the collector plates until the unit is de-energized and cleaned

F. Filtered air is ready to be conditioned by heating or cooling system

VII. Operation of a dehumidifier (Transparency 3)

(NOTE: A dehumidifier is a small hermetic refrigerating system with an evaporator and condenser both enclosed in a cabinet.)

A. Room or conditioned air is drawn into the unit by a blower

B. Air is cooled as it passes over the evaporator coil

C. Water vapor in the air condenses as it is cooled below its dew point

D. Condensation collects on the evaporator and drips into a collector tray and is removed

E. The cooled air is passed over the condensor coil to reheat it to a comfortable RH

F. Treated air is blown into the room or ductwork

(NOTE: Some dehumidifiers use a chemical to remove water. Moisture is absorbed by the chemical and the chemical is heated to remove the moisture in another part of the unit. Moisture is then exhausted to outside air and the chemical is reused.)

VIII. Operation of a typical humidifer with a forced air furnace

A. The humidifier is installed on the return air plenum or duct and connected to the supply air plenum with flexible pipe (Figure 1)

B. The by-passed supply (warm) air flows over a moist foam filter which rotates in a water reservoir

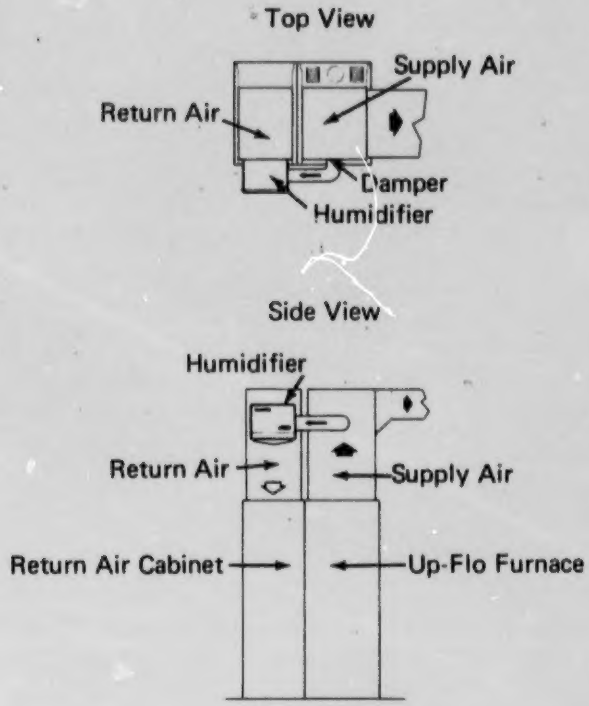
C. The moistened warm air reenters the air stream on the return air side of the furnace

D. A humidifer with a separate fan is controlled by a humidistat

(NOTE: Some humidifiers spray a fine mist of water into the system, some work with pans or drums, but all types are designed to increase the RH of supply air when heating makes household air too dry.)

INFORMATION SHEET

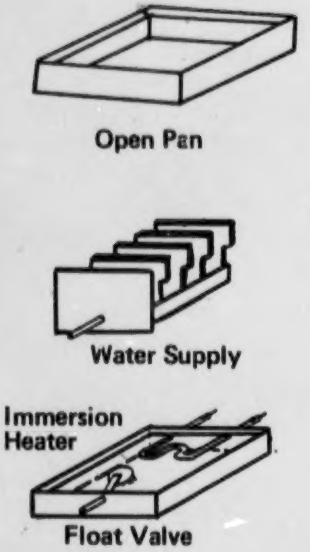
FIGURE 1



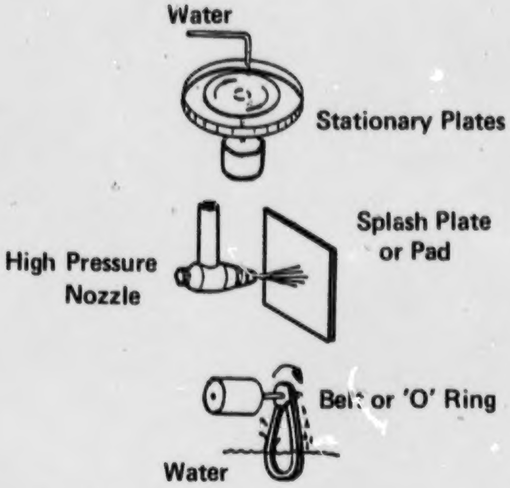
Up-flo Unit

(Courtesy of Lennox Industries)

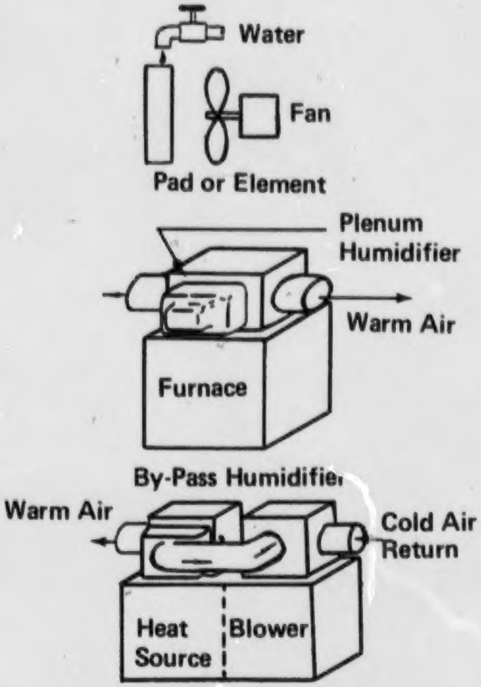
Types of Humidifiers



Pan Type Humidifiers

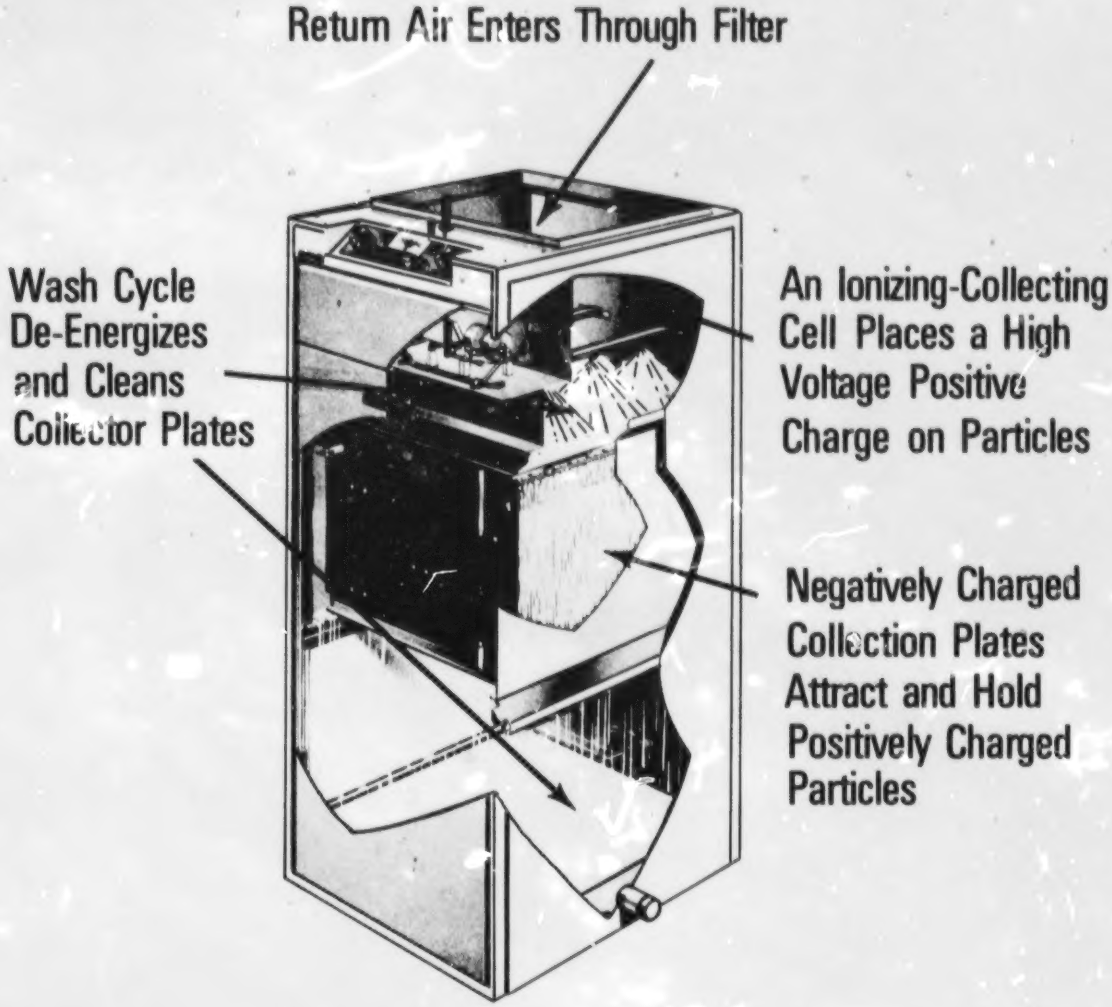


Atomizing Humidifiers



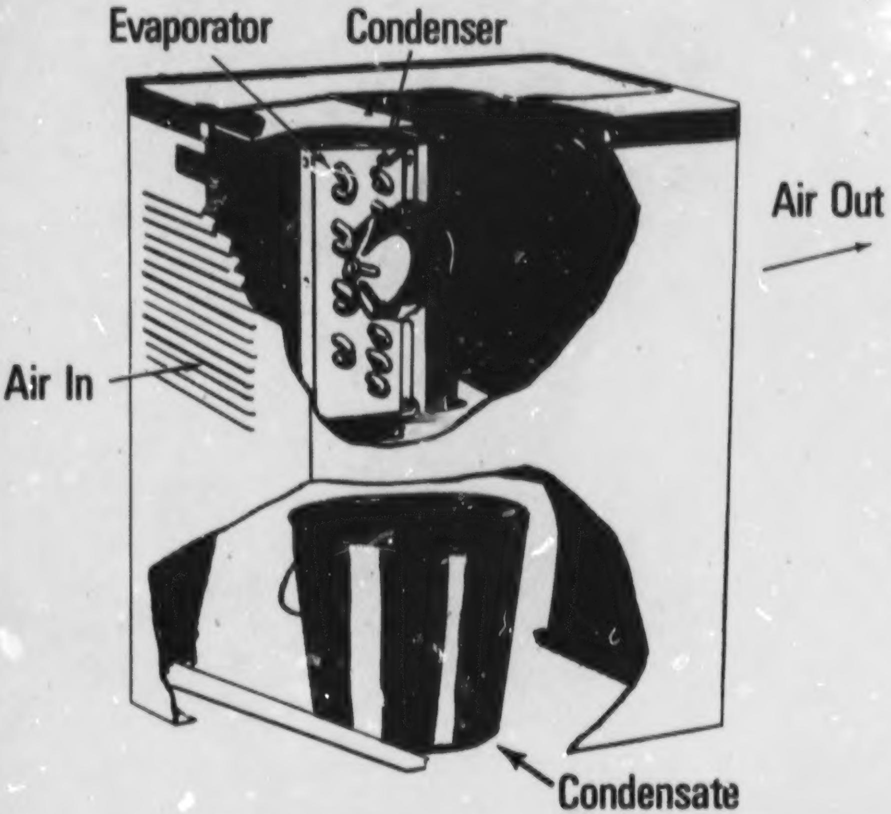
Wetted Element Humidifiers

Electronic Air Cleaner Operation


Return Air Enters Through Filter
Wash Cycle De-Energizes and Cleans Collector Plates
An Ionizing-Collecting Cell Places a High Voltage Positive Charge on Particles
Negatively Charged Collection Plates Attract and Hold Positively Charged Particles

(Courtesy of Lennox Industries)

Components of a Dehumidifier



(Courtesy of International Harvester)

AIR TREATMENT
UNIT VIII

JOB SHEET #1--INSTALL A HUMIDIFIER WITH LOW VOLTAGE CONTROLS

I. Tools and equipment

   A. Humidifier and accessories

   B. Screwdriver

   C. Aviation snips

   D. 1/4" OD copper tubing as needed

   E. Thermostat cable (2-wire #18) as needed

   F. SPST relay (24v coil)

   G. #14 insulated stranded wire as needed

   H. 1/4" sheet metal screws (if needed)

   I. Other materials specified by manufacturer's instructions

   J. Forced air heating system as selected by instructor

II. Procedure

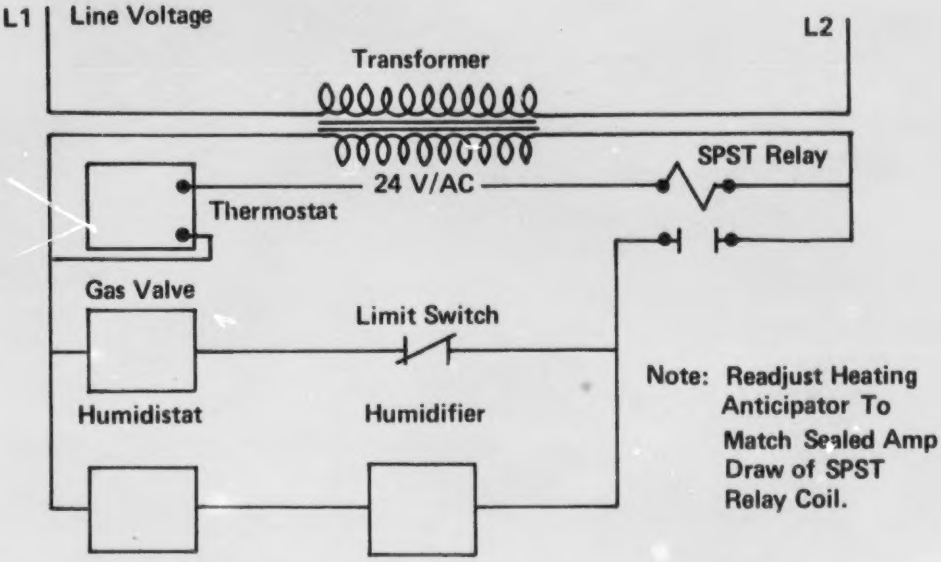
   A. Disconnect power source to system

   B. Mount humidistat next to thermostat

JOB SHEET #1

C. Install low voltage wiring and relay in accordance with the diagram shown in Figure 1

FIGURE 1



Note: Readjust Heating Anticipator To Match Sealed Amp Draw of SPST Relay Coil.

D. Mount humidifier according to manufacturer's instructions

E. Install saddle valve in cutoff

F. Connect cutoff to humidifier with copper tubing

G. Connect electrical components

H. Reconnect power source

I. Run system and humidifier long enough to verify correct operation

AIR TREATMENT
UNIT VIII

JOB SHEET #2--INSTALL AN ELECTRONIC FILTER

I. Tools and equipment

- A. Electronic filter and accessories
- B. Aviation snips
- C. Twenty-four 1/2" sheet metal screws
- D. Screwdriver
- E. 1/4" nut driver
- F. Heating system as selected by instructor

II. Procedure

- A. Disconnect system power source
- B. Mount electronic filter in return air passage

  (NOTE: Follow manufacturer's instructions carefully.)
- C. Connect electrical supply to filter according to manufacturer's instructions
- D. Reconnect system power source
- E. Run system with filter long enough to verify correct operation

AIR TREATMENT
UNIT VIII

NAME________________________________

TEST

1. Match the terms on the right with their correct definitions.

_____a. A unit of linear measurement which is one thousandth of a millimeter

_____b. A control for regulating humidity in conditioned air

_____c. An electric heating element in a water container

_____d. A filter which contains matted or porous material for removing foreign particles from conditioned air

_____e. Minute particles of various solid substances in the air

_____f. Airborne substances which cause allergies in humans

_____g. Relative humidity

_____h. Process of breaking a substance into positive and negative particles or charges

1. Particulates
2. RH
3. Micron
4. Aeroallergens
5. Humidistat
6. Ionization
7. Immersion heater
8. Impingement type filter

2. Describe air contaminants which affect humans.

a.

b.

3. List four advantages of maintaining proper humidity in a residence.

a.

b.

c.

d.

4. Select from the following statements those factors which affect humidity in a residence by placing an "X" in the appropriate blanks.

_____a. Outside air temperature

_____b. Temperature of conditioned air

_____c. Appliance use and food preparation

_____d. Number of occupants and activities

_____e. Plumbing and water usage

_____f. Ground water level

_____g. Size of the lot the residence is built on

5. Complete the following chart showing features of common types of residential filtering equipment.

Type	Permanent Filter	Throw-away Filter	Electronic
Initial cost	average	low	
Filter source	Adhesive coating	Adhesive screen-like fibers	
Service or maintenance	average-clean and recoat plates	simple-replace filter	
Operating cost	average	low	
Effectiveness	good	average	

6. Select true statements concerning the operation of an electronic filter by placing an "X" in the appropriate blanks.

_____a. Return air first passes through a throw away filter to remove larger particles

_____b. Partially filtered air enters an ionized field

_____c. A wire grid with high positive voltage charges the particles in the air

_____d. Negatively charged plates attract the particles that have been positively charged

_____e. The particles are immediately washed off the collector plates

_____f. Filtered air is ready to be conditioned by heating or cooling system

7. Select true statements concerning operation of a dehumidifier by placing an "X" in the appropriate blanks.

_____a. Outside air is drawn into the unit by a blower

_____b. Air is cooled as it passes over the evaporator coil

_____c. Water vapor in the air condenses as it is cooled below its dew point

_____d. Condensation collects on the evaporator and drips into a collector tray and is removed

_____e. The cooled air is passed over the condensor coil to further cool it to a comfortable RH

_____f. Treated air is blown into the room or ductwork

8. Select true statements concerning the operation of a typical humidifier with a forced air furnace by placing an "X" in the appropriate blanks.

_____a. The humidifier is installed on the return air plenum or duct and connected to the supply air plenum with flexible pipe

_____b. The by-passed supply air flows over a moist foam filter which rotates in a water reservoir

_____c. The moistened warm air reenters the air stream on the supply air side of the furnace

_____d. A humidifier with a separate fan is controlled by a thermostat

9. Demonstrate the ability to:

a. Install a humidifier with low voltage controls.

b. Install an electronic filter.

(NOTE: If these items have not been accomplished prior to the test, ask your instructor when they should be completed.)

AIR TREATMENT
UNIT VIII

ANSWERS TO TEST

1. a. 3
   b. 5
   c. 7
   d. 8
   e. 1
   f. 4
   g. 2
   h. 6

2. Description should include:

   a. Size

      1) Larger than 2 microns will be expelled by the lungs

      2) Smaller than 2 microns will be retained in the lungs

   b. Type

      1) Particulates

      2) Aeroallergens

3. Any four of the following:

   a. Promotes health by maintaining moisture needed by mucous membranes in nasal passages

   b. Reduces static electricity in floor coverings

   c. Prolongs life of wooden furniture by preventing drying of glued joints

   d. Prolongs life of textiles

   e. Reduces house dust

   f. Prolongs life of window sills, doors, and other construction materials

   g. Promotes human comfort

4. a, b, c, d, e

5.

Type	Permanent Filter	Throw-away Filter	Electronic
Initial cost	average	low	high
Filter source	Adhesive coating	Adhesive screen-like fibers	Opposing electrical charged elements and primary fiber filter
Service or maintenance	average-clean and recoat plates	simple-replace filter	average-wash elements
Operating cost	average	low	high
Effectiveness	good	average	excellent

6. a, b, c, d, f

7. b, c, d, f

8. a, b

9. Evaluated to the satisfaction of the instructor

RESIDENTIAL SYSTEMS
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the components of various residential systems and discuss their operation and construction. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to residential systems with their correct definitions.
2. List major factors in furnace design.
3. Identify the major components in furnace construction.
4. List furnace control devices.
5. Identify the components of a gas furnace burner assembly.
6. Identify the components of an oil furnace burner assembly.
7. Select true statements concerning the operation of fan and limit switches.
8. Identify the components of a hydronic system furnace.
9. Identify the basic components of a cooling system.
10. Match cooling system components with their functions.
11. Select true statements concerning the process of evaporative cooling.
12. Select true statements concerning limitations of evaporative cooling.
13. Select true statements concerning heat pump design and operation.

RESIDENTIAL SYSTEMS
UNIT IX

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information sheet.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Major Components in Furnace Constuction
    2. TM 2--Components of Burner Assemblies
    3. TM 3--Components of a Hydronic System Furnace
    4. TM 4--Basic Components of a Cooling System
    5. TM 5--Basic Components of an Evaporative Cooling System
    6. TM 6--Heat Pump Operation Heating Mode
    7. TM 7--Heat Pump Operation Cooling Mode

  D. Test

  E. Answers to test

II. References:

  A. Weaver, Michael, and James Kirkpatrick. *Environmental Control*. New York: Harper and Row, 1974.

  B. Althouse, Andrew, and Carl Turnquist and Alfred Bracciano. *Modern Refrigeration and Air Conditioning*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1975.

RESIDENTIAL SYSTEMS
UNIT IX

INFORMATION SHEET

I. Terms and definitions

   A. Thermocouple–Serves as a safety device on gas furnaces to cut off the gas supply in the event of loss of flame in the pilot light

   B. Gas pressure regulator--A device which reduces pressure from main line connection to the burner assembly and maintains a constant even gas flow to the burners

   C. Pilot light--A small flame located near the main burners in a gas furnace which ignites the gas during the heat-on cycle

   D. Solenoid--An electromagnetic device that mechanically operates a switch, valve, or similar control on low voltage electrical signals provided from remote sensors or controls such as a thermostat

   E. Relay--An electrical device that controls the operation of a motor on a fan or pump using high voltage current

   F. Transformer--An electrical device that changes high voltage current to lower voltage to enable switches and similar devices to be used as operating controls

   G. Draft diverter--A device used on gas furnaces to prevent back drafts from entering the combustion chamber and extinguishing the flame

   H. Flue damper–A damper in a flue; it closes the flue when the flame shuts off

   I. Orifice--A small opening or hole drilled in metal to precisely regulate flow of fluid or gas

   J. Barometric damper--An adjustable device located on the chimney which is used to control the amount of updraft in a furnace to provide the proper amount of air for combustion

II. Major factors in furnace design

   A. Fuel or heat source used

   B. Heat transfer medium (air, water, or steam)

III. Major components in furnace construction (Transparency 1)

   A. Combustion chamber (except electric)

   B. Burner assembly (heat source)

   C. Flue (except electric)

INFORMATION SHEET

- D. Heat exchanger (or boiler)
- E. Draft diverter (or damper, except electric)
- F. Blower assembly
- G. Air filter
- H. Cabinet

IV. Furnace control devices

- A. Room thermostat
- B. Step down transformer
- C. Fuel control solenoid valve
- D. Blower control switch
- E. Limit switch
- F. Thermocouple (gas) or ignition relay (oil)

V. Components of a gas furnace burner assembly (Transparency 2)

- A. Burner assembly
- B. Manifold
- C. Thermocouple
- D. Main gas valve
- E. Gas pressure regulator
- F. Pilot light
- G. Gas control solenoid valve

(NOTE: Gas burner assemblies usually have 24-volt thermostat and limit controls supplied from a 24-volt transformer.)

VI. Components of an oil furnace burner assembly (Transparency 2)

- A. Oil pump
- B. Combustion air blower
- C. Blower and pump motor
- D. Nozzle and air tube
- E. Ignition electrodes
- F. Burner head and choke

INFORMATION SHEET

VII. Operation of fan and limit switches

(NOTE: Limit switches are safety controls to prevent damage created by overheating of the air exchange chamber; fan switches control the air handling blower motors.)

A. The blower motor is controlled by a control switch in the plenum chamber

(NOTE: Some blower controls use a time delay solid state control.)

B. Blower operates independently of the limit control when plenum temperature reaches approximately 140°F

C. Blower continues to operate until plenum temperature drops below 90°F

D. Blower control switch can be set to operate continuously to circulate air as needed

E. Limit switch is closed at temperatures below 200°F

F. When temperature exceeds the preset level the switch will open

G. The electrical circuit is interrupted to fuel control valve or to oil gun type burner

H. The fuel supply is cut off to stop the combustion process

I. When a temperature drops below 160°F the switch will close the circuit to turn on full supply again

VIII. Components of a hydronic system furnace (Transparency 3)

(NOTE: In addition to the air handling equipment of a warm air furnace the hydronic furnace requires a boiler assembly and pumping or water handling equipment. This description is limited to the water handling equipment needed.)

A. Boiler or water jacket

B. Water pump

C. Water pressure gauge

D. Temperature sensing switch

E. Pressure relief valve

F. Expansion chamber or compression tank

G. Heat source

(NOTE: Modern hydronic furnaces are usually tied into radiant baseboard heaters through a hot water coil and a pressure regulator.)

INFORMATION SHEET

IX. Basic components of a cooling system (Transparency 4)

   A. Suction line

   B. Evaporator

   C. Liquid refrigerant line

   D. Compressor

   E. Condenser

   F. Metering device

X. Cooling system components and their functions

   A. Suction line--Feeds low pressure gas into the suction side of the compressor

   B. Evaporator--Turns the refrigerant from a liquid into a gas through evaporation

   C. Liquid refrigerant line--Feeds liquid refrigerant under high pressure into the metering device

   D. Compressor--Compresses the low pressure gas refrigerant into a high pressure gas

   E. Condenser--Condenses the refrigerant from a gas into a liquid

   F. Metering device--Meters the flow of refrigerant

XI. The process of evaporative cooling (Transparency 5)

   A. Air is drawn through a water spray or a wet pad

   B. The incoming air supplies the latent heat needed to evaporate the water

   C. The evaporating water is replaced by water pumped into a makeup pan controlled by a water float

   D. Dry-bulb temperature decreases

   E. Relative humidity and dewpoint temperature increases

   F. Wet-bulb temperature remains the same

INFORMATION SHEET

XII. Limitations of evaporative cooling

- A. Can be used effectively only where the difference between the outdoor wet-bulb temperature and outdoor dry-bulb temperature is relatively high
- B. Can be used effectively only where the relative humidity is low
- C. Is ineffective in spaces requiring constant temperature and humidity control (hospitals, electronic installations, etc.)

XIII. Heat pump design and operation (Transparencies 6 and 7)

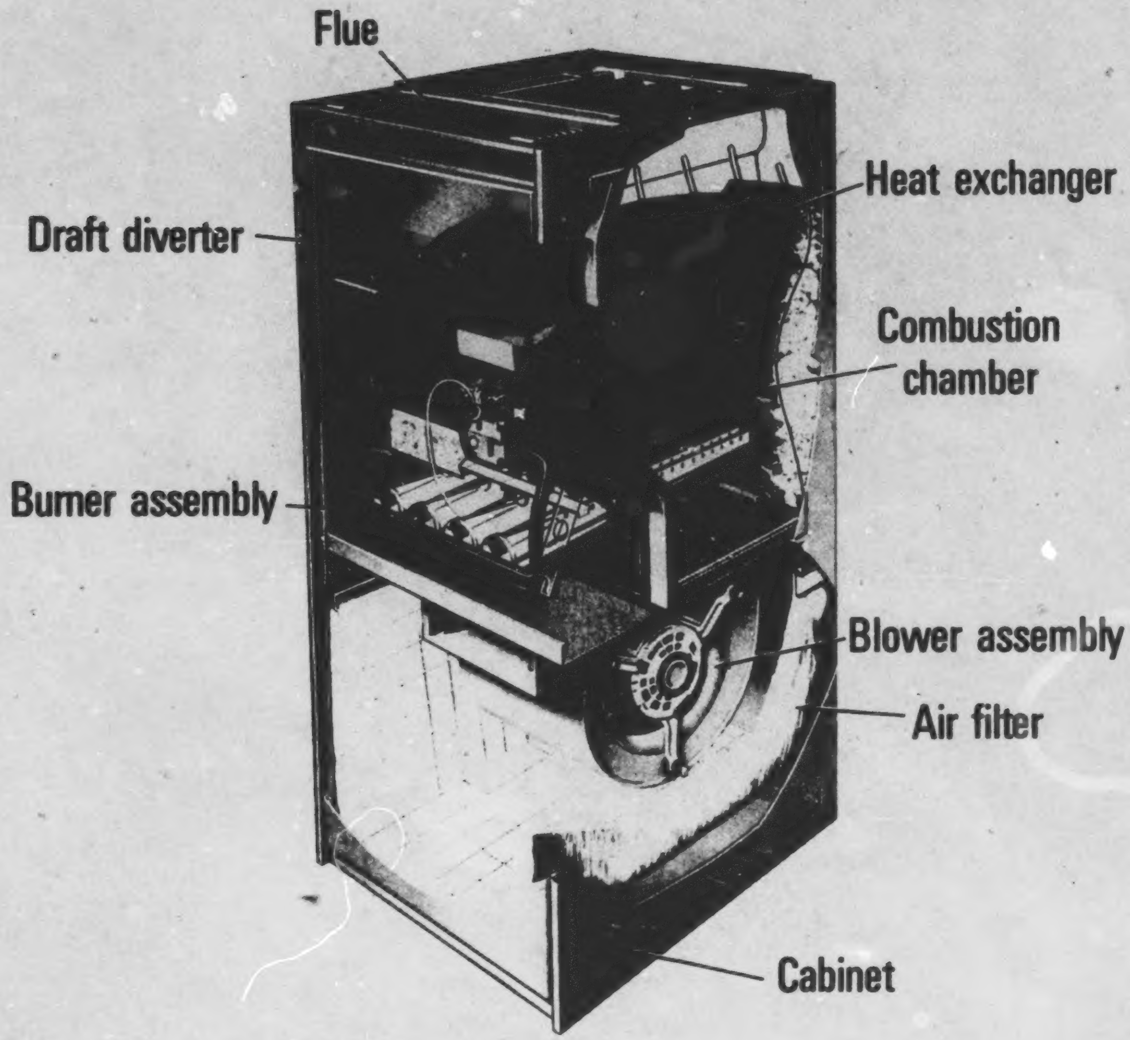
- A. A heat pump is basically a two coil air conditioner that can be used for cooling in the summer and heating in the winter
- B. The dual function of a heat pump is accomplished by reversing the flow of refrigerant so that the inside coil becomes a condenser and the outside coil becomes an evaporator
- C. Refrigerant reversal is accomplished with a reversing valve which in turn is controlled by a solenoid operated pilot valve
- D. The inside coil is usually a finned coil with a blower
- E. The outside coil design depends on what substance the coil releases its heat to or picks up its heat from

  (NOTE: Outside coils can function as air coils, ground coils, coils placed in lake water, or coils placed deep in geothermal wells.)
- F. Heat pumps are electrically operated and are usually effective energy savers when properly installed

  (NOTE: Early heat pumps had problems with ice buildup in outdoor components, but new design features have corrected most of these problems, and manufacturer's installation directions should be followed carefully.)

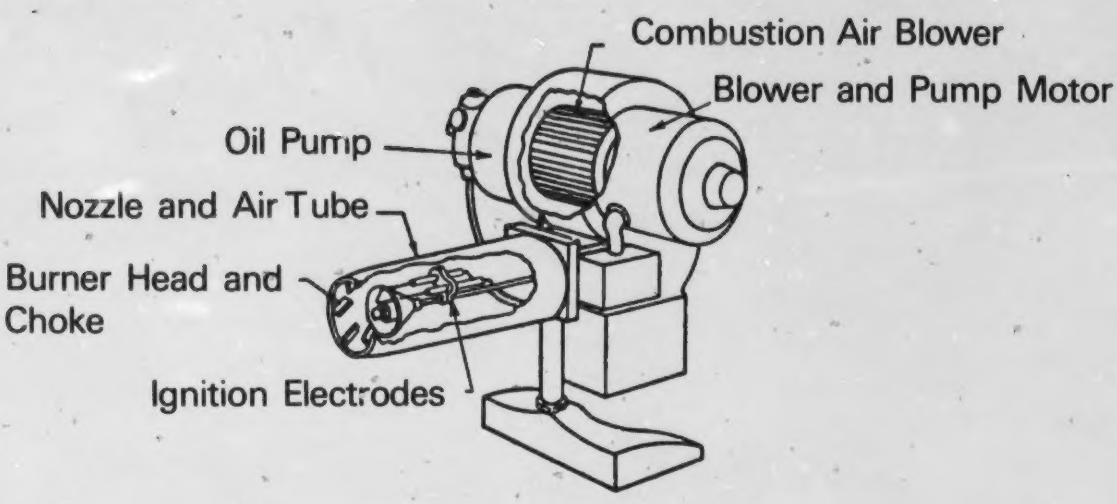
Major Components in Furnace Construction

(Gas Fired)



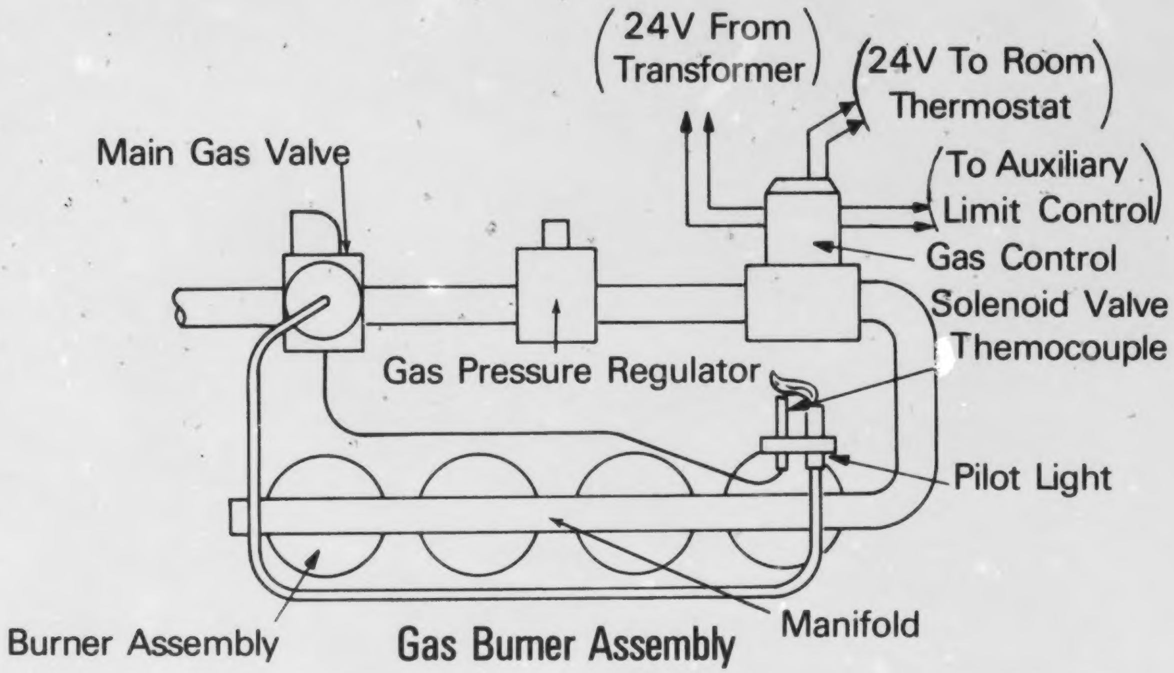
(Courtesy of Lennox Industries)

Components of Burner Assemblies



Oil Burner Assembly

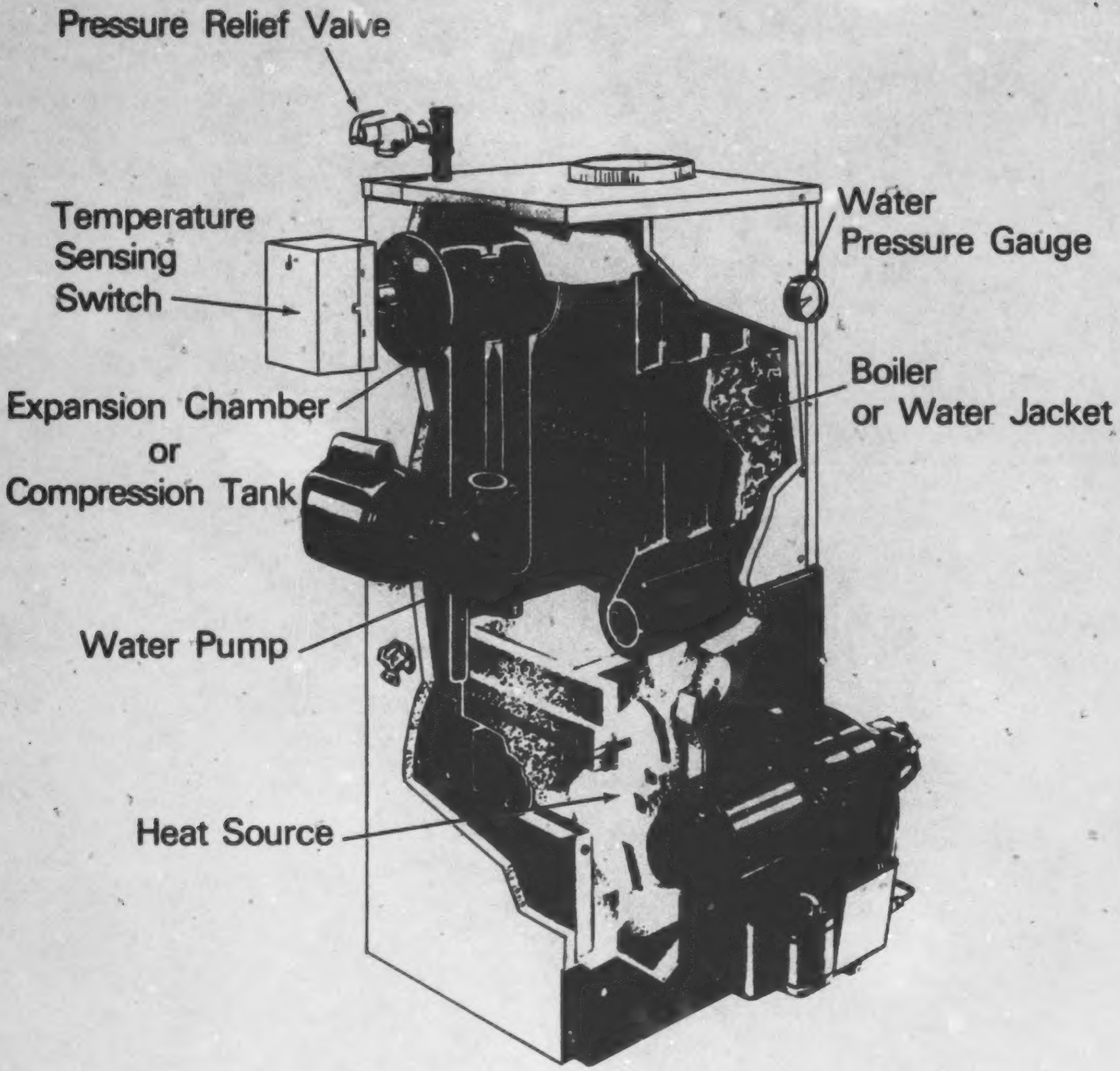
(Courtesy of The Goodheart-Willcox Co., Inc.)



Gas Burner Assembly

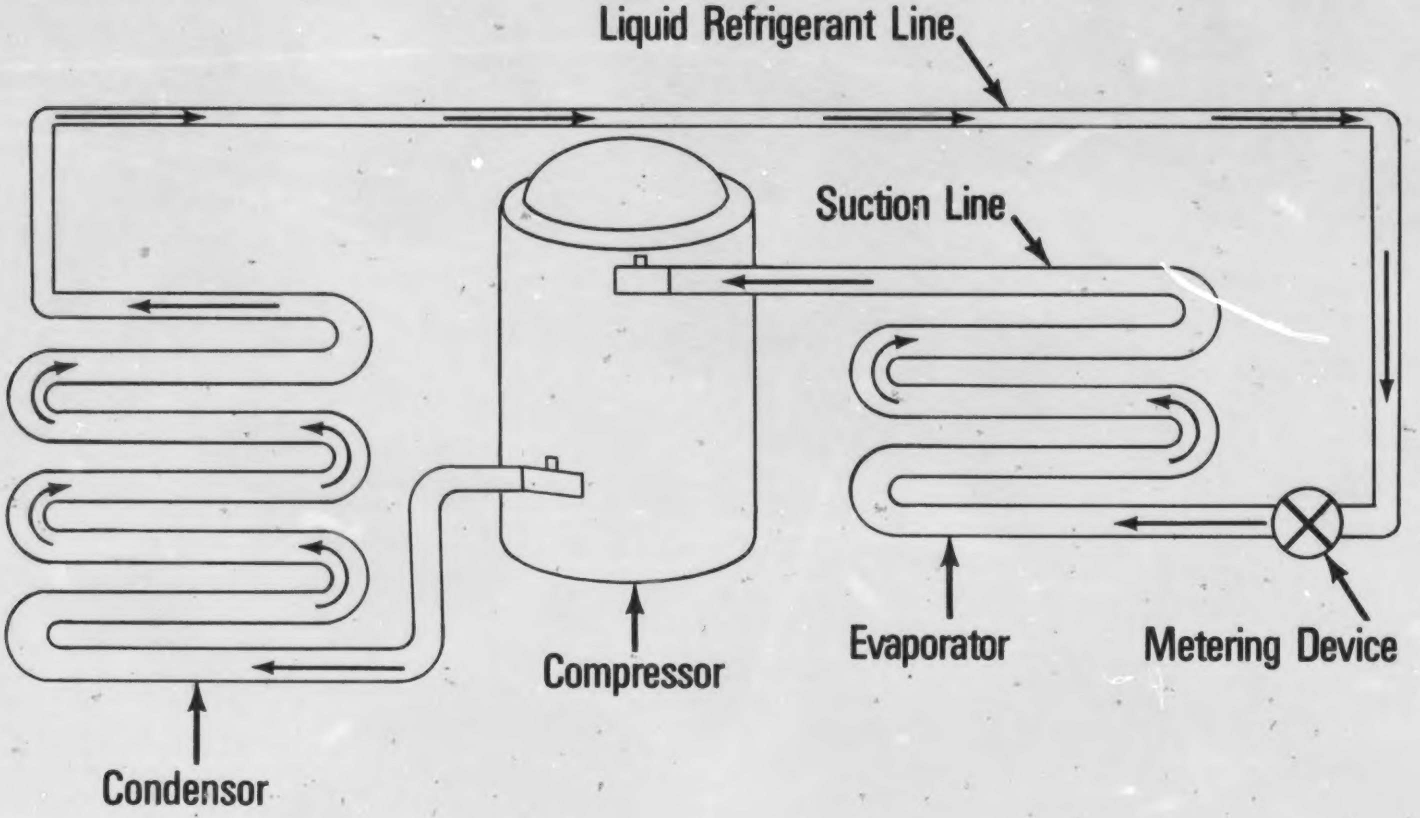
(Oil burner assembly courtesy of The Goodheart-Willcox Co., Inc.)
(Gas burner assembly courtesy of Harper & Row, Publishers)

Components of a Hydronic System Furnace



(Courtesy of American Standard, Inc.)

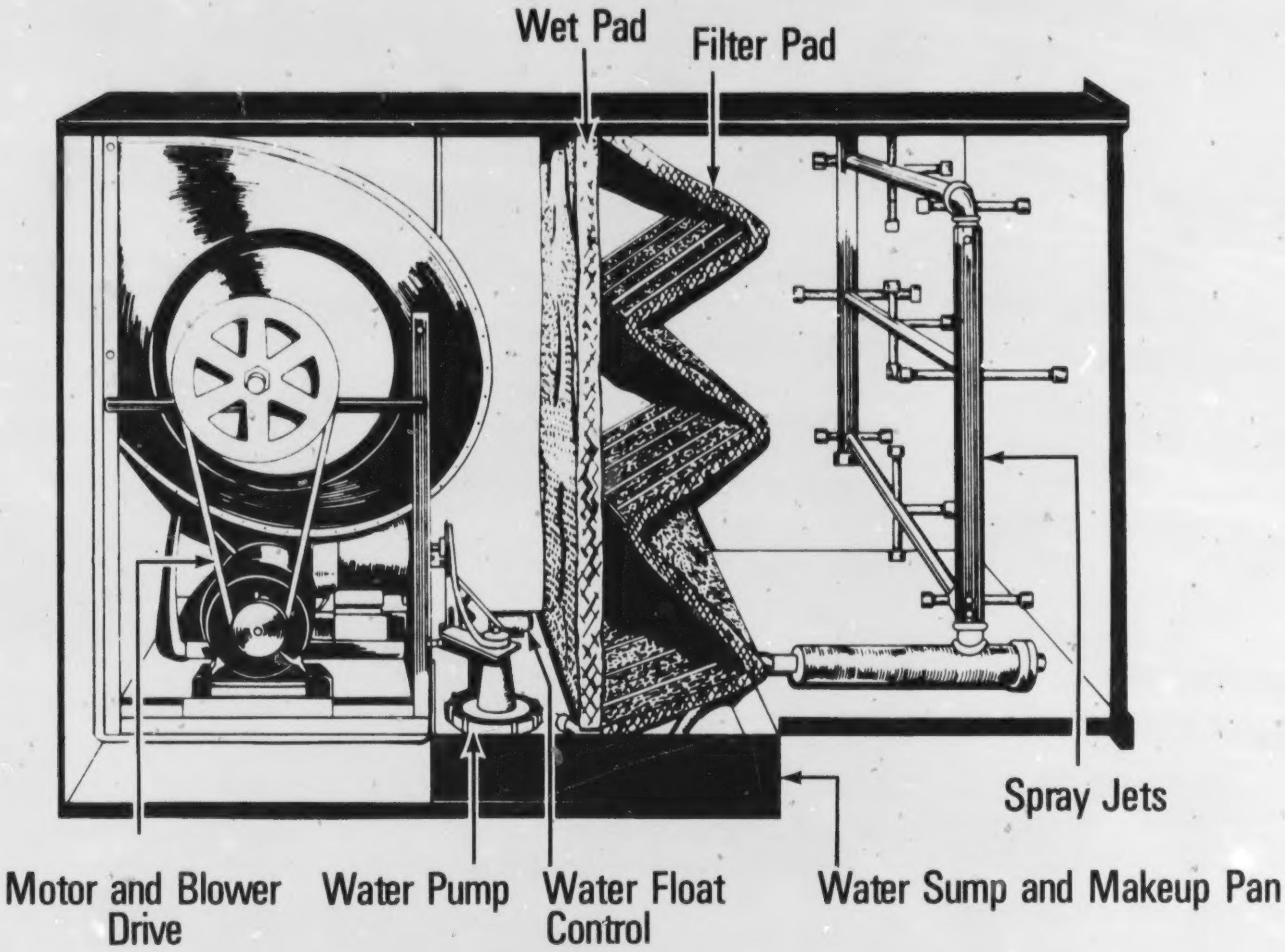
Basic Components of a Cooling System



TM 4

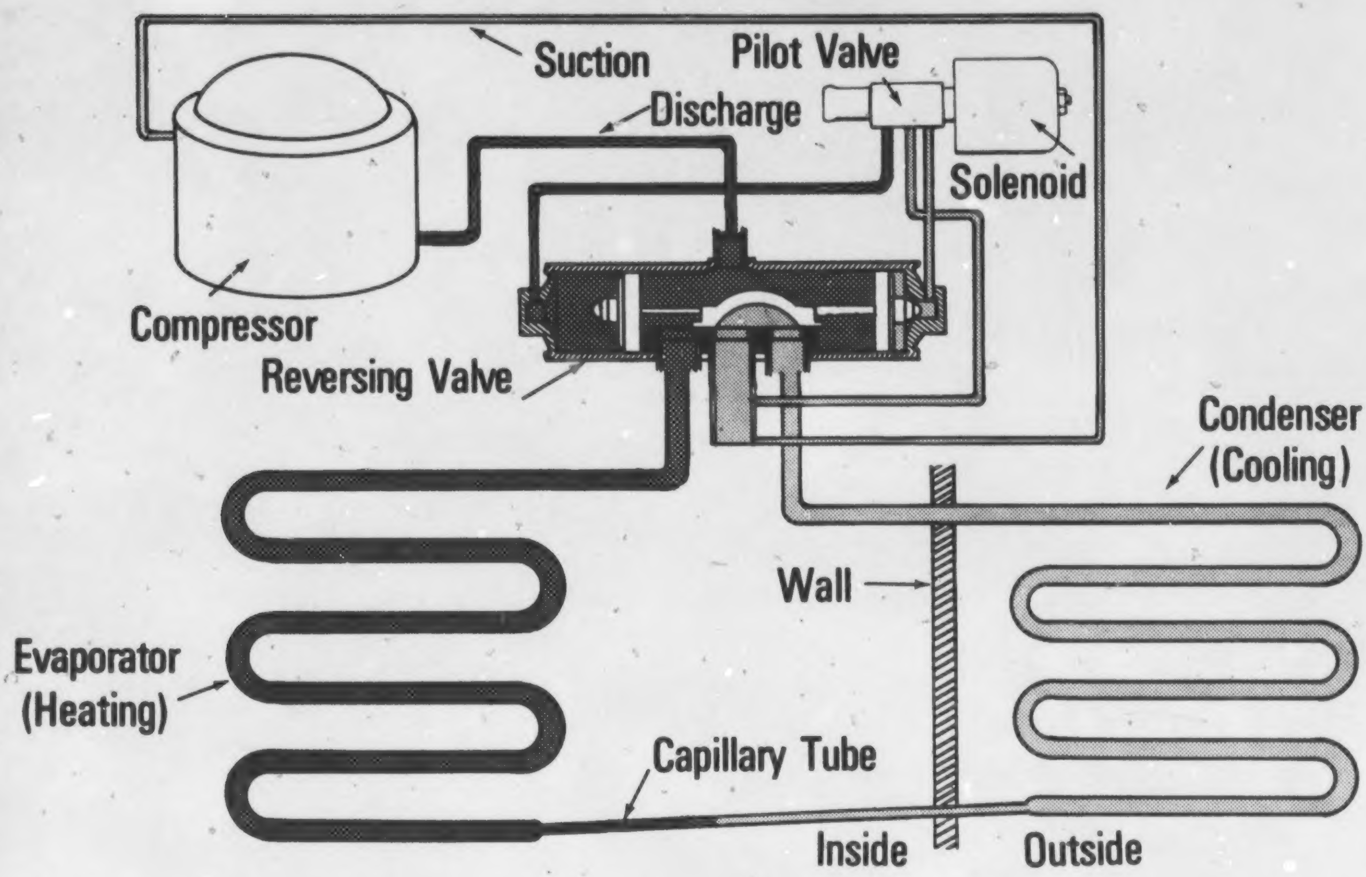
ACR III - 289

Basic Components of an Evaporative Cooling System



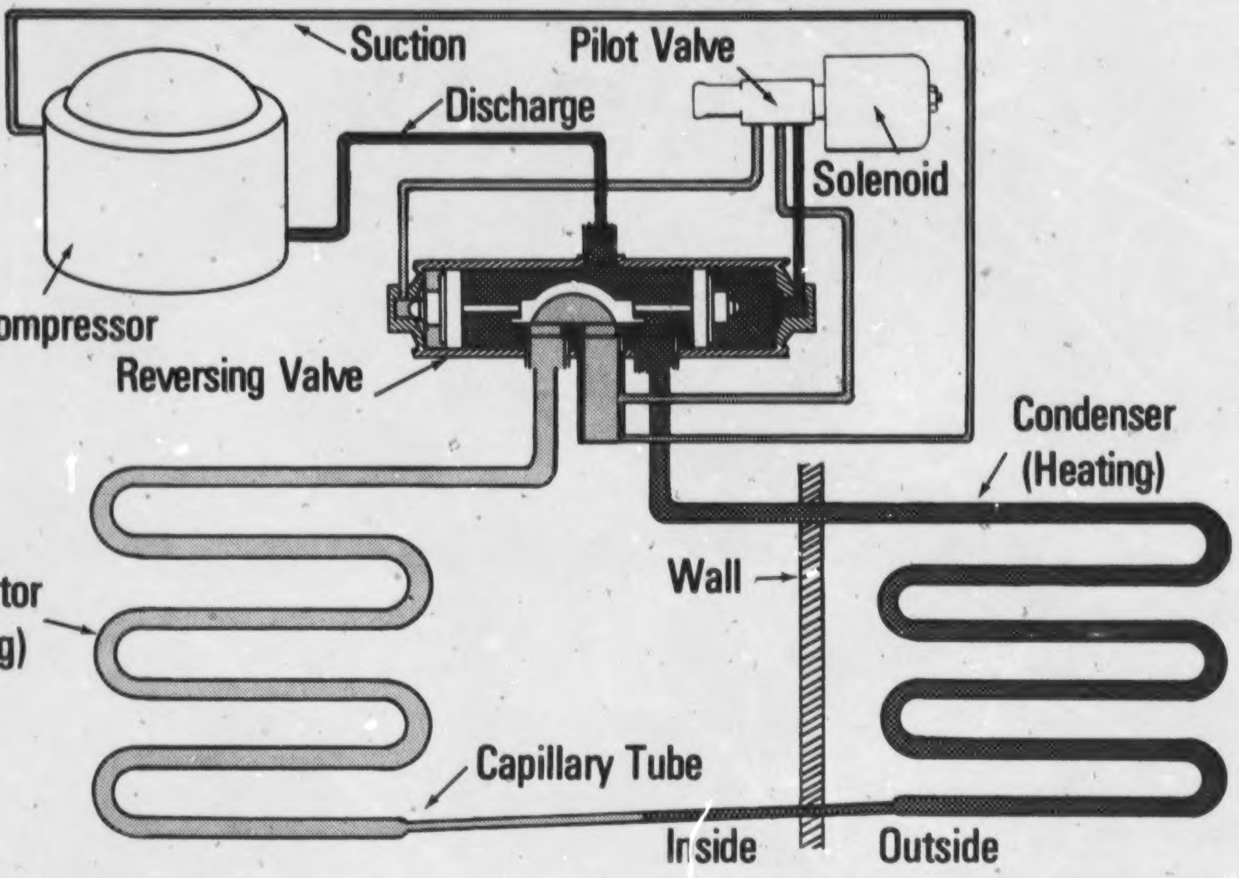
(Courtesy of The U. S. Air Force)

Heat Pump Operation
Heating Mode



ACR III - 293

Heat Pump Operation
Cooling Mode



RESIDENTIAL SYSTEMS
UNIT IX

NAME ______________________

TEST

1. Match the terms on the right with their correct definitions.

_____a. Serves as a safety device on gas furnaces to cut off the gas supply in the event of loss of flame in the pilot light

_____b. A device which reduces pressure from main line connection to the burner assembly and maintains a constant even gas flow to the burners

_____c. A small flame located near the main burners in a gas furnace which ignites the gas during the heat-on cycle

_____d. An electromagnetic device that mechanically operates a switch, valve or similar control on low voltage electrical signals provided from remote sensors or controls such as a thermostat

_____e. An electrical device that controls the operation of a motor on a fan or pump using high voltage current

_____f. An electrical device that changes high voltage current to lower voltage to enable switches and similar devices to be used as operating controls

_____g. A device used on gas furnaces to prevent back drafts from entering the combustion chamber and extinguishing the flame

_____h. A damper in a flue; it closes the flue when the flame shuts off

_____i. A small opening or hole drilled in metal to precisely regulate flow of fluid or gas

_____j. An adjustable device located on the chimney which is used to control the amount of updraft in a furnace to provide the proper amount of air for combustion

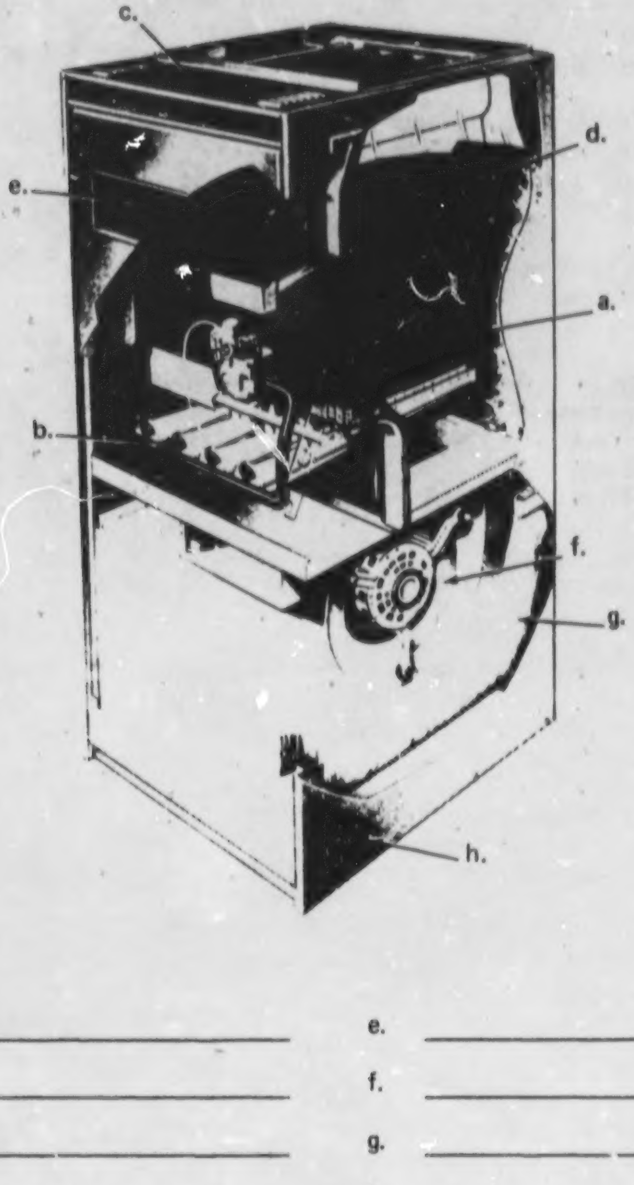
1. Draft diverter
2. Pilot light
3. Orifice
4. Barometric damper
5. Gas pressure regulator
6. Flue damper
7. Relay
8. Thermocouple
9. Solenoid
10. Transformer

2. List two major factors in furnace design.

a.

b.

3. Identify the major components in furnace construction by correctly labeling the following illustration.



a. ______________________ e. ______________________

b. ______________________ f. ______________________

c. ______________________ g. ______________________

d. ______________________ h. ______________________

4. List five furnace control devices.

   a.

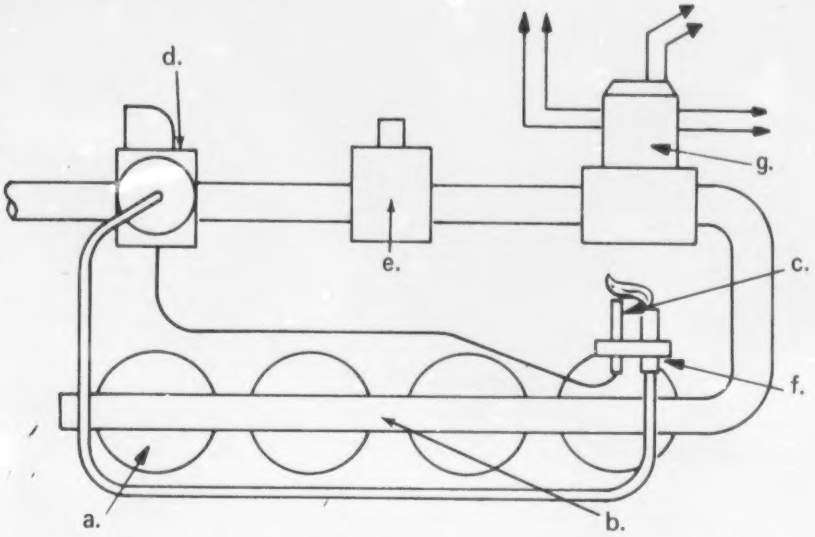
   b.

   c.

   d.

   e.

5. Identify the components of a gas furnace burner assembly by correctly labeling the following illustration.



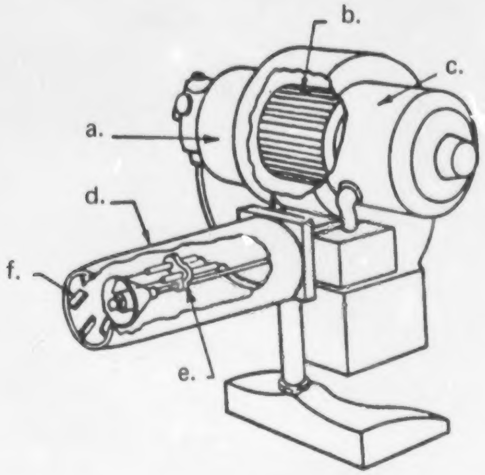
a. ______________________ e. ______________________

b. ______________________ f. ______________________

c. ______________________ g. ______________________

d. ______________________

6. Identify the components of an oil furnace burner assembly by correctly labeling the following illustration.



a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

7. Select true statements concerning the operation of fan and limit switches by placing an "X" in the appropriate blanks.

_____a. The blower motor is controlled by a control switch in the plenum chamber

_____b. Blower operates independently of the limit control when plenum temperature reaches approximately 140°F

_____c. Blower continues to operate until plenum temperature drops below 90°F

_____d. Blower control switch can be set to operate continuously to circulate air as needed

_____e. Limit switch is closed at temperatures below 200°F

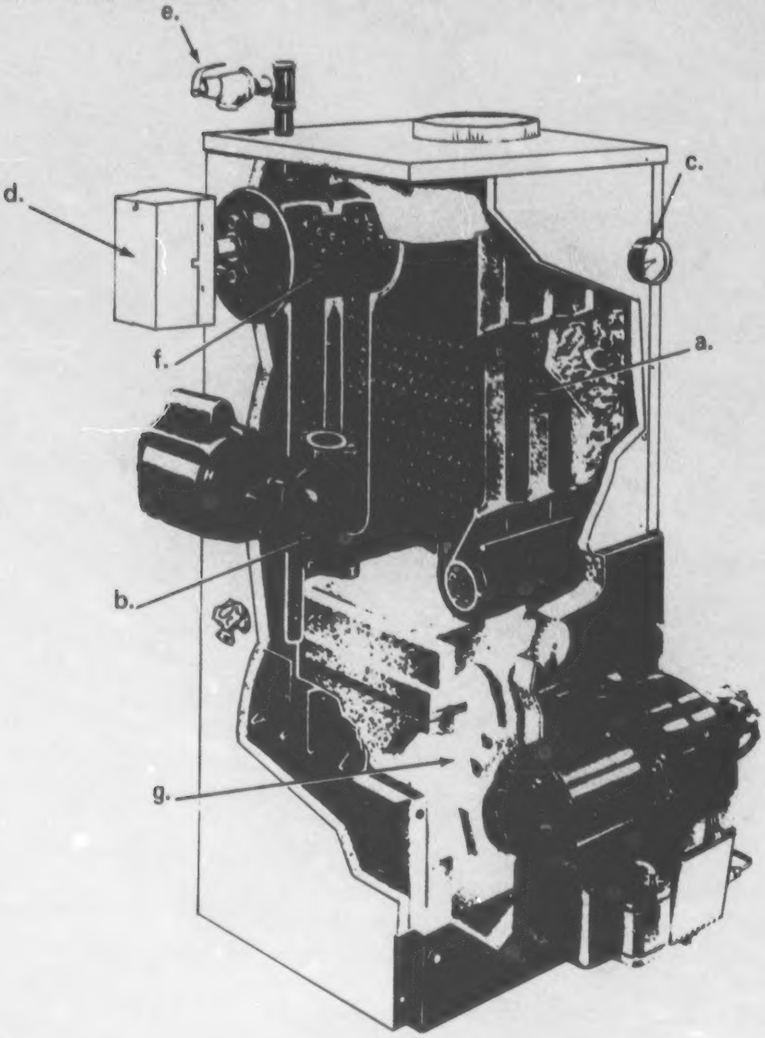
_____f. When temperature exceeds the preset level the switch will open

_____g. The electrical circuit is interrupted to fuel control valve or to oil gun type burner

_____h. The fuel supply is cut off to stop the combustion process

_____i. When a temperature drops below 160°F the switch will close the circuit to turn on full supply again

8. Identify the components of a hydronic system furnace by correctly labeling the following illustration.



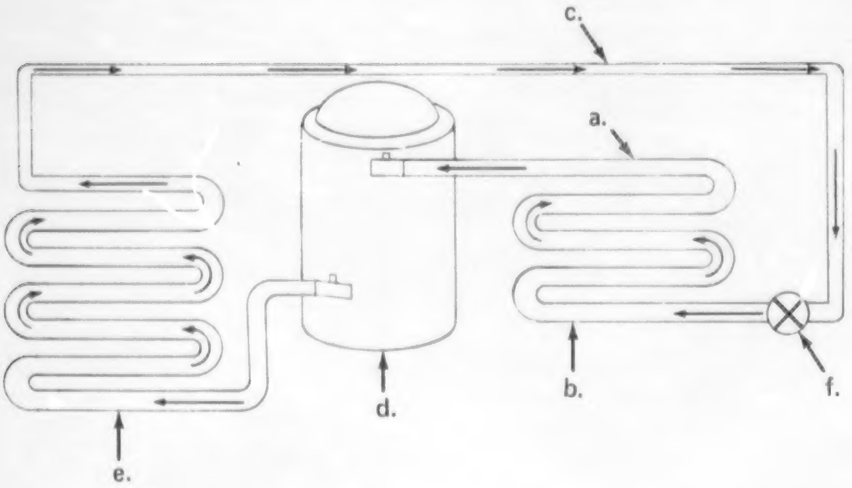
a. ______________________ e. ______________________

b. ______________________ f. ______________________

c. ______________________ g. ______________________

d. ______________________

9. Identify the basic components of a cooling system by correctly labeling the following illustraton.



a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

10. Match cooling system components on the right with their functions.

_____a. Feeds low pressure gas into the suction side of the compressor

_____b. Turns the refrigerant from a liquid into a gas through evaporation

_____c. Feeds liquid refrigerant under high pressure into the metering device

_____d. Compresses the low pressure gas refrigerant into a high pressure gas

_____e. Condenses the refrigerant from a gas into a liquid

_____f. Meters the flow of refrigerant

1. Compressor
2. Metering device
3. Suction line
4. Condenser
5. Liquid refrigerant line
6. Evaporator

11. Select true statements concerning the process of evaporative cooling by placing an "X" in the appropriate blanks.

_____a. Air is drawn through a water spray or a wet pad

_____b. The incoming air supplies the latent heat needed to evaporate the water

_____c. The evaporating water is replaced by water pumped into a makeup pan controlled by a water float

_____d. Dry-bulb temperature increases

_____e. Relative humidity and dewpoint temperature decreases

_____f. Wetbulb temperature increases

12. Select true statements concerning the limitations of evaporative cooling by placing an "X" in the appropriate blanks.

_____a. Can be used effectively only where the difference between the outdoor wet-bulb temperature and outdoor dry-bulb temperature is relatively high

_____b. Can be used effectively only where the relative humidity is high

_____c. Is ineffective in spaces requiring constant temperature and humidity control

13. Select true statements concerning heat pump design and operation by placing an "X" in the appropriate blanks.

_____a. A heat pump is basically a complex evaporative cooling system

_____b. The dual function of a heat pump is accomplished by reversing the flow of refrigerant so that the inside coil becomes a condenser and the outside coil becomes an evaporator

_____c. Refrigerant reversal is accomplished with a reversing valve which in turn is controlled by a solenoid operated pilot valve

_____d. The inside coil is usually a finned coil with a blower

_____e. The outside coil can only be placed in the ground

_____f. Heat pumps are electrically operated and are usually effective energy savers when properly installed

RESIDENTIAL SYSTEMS
UNIT IX

ANSWERS TO TEST

1. a. 8
   b. 5
   c. 2
   d. 9
   e. 7
   f. 10
   g. 1
   h. 6
   i. 3
   j. 4

2. a. Fuel or heat source used

   b. Heat transfer medium

3. a. Combustion chamber
   b. Burner assembly
   c. Flue
   d. Heat exchanger
   e. Draft diverter or damper
   f. Blower assembly
   g. Air filter
   h. Cabinet

4. Any five of the following:

   a. Room thermostat
   b. Step down transformer
   c. Fuel control solenoid valve
   d. Blower control switch
   e. Limit switch
   f. Thermocouple or ignition relay

5. a. Burner assembly
   b. Manifold
   c. Thermocouple
   d. Main gas valve
   e. Gas pressure regulator
   f. Pilot light
   g. Gas control solenoid valve

6. a. Oil pump
   b. Combustion air blower
   c. Blower and pump motor
   d. Nozzle and air tube
   e. Ignition electrodes
   f. Burner head and choke

7. a, b, c, d, e, f, g, h, i

8. a. Boiler or water jacket
   b. Water pump
   c. Water pressure gauge
   d. Temperature sensing switch
   e. Pressure relief valve
   f. Expansion chamber or compression tank
   g. Heat source

9. a. Suction line
   b. Evaporator
   c. Liquid refrigerant line
   d. Compressor
   e. Condenser
   f. Metering device

10. a. 3 d. 1
    b. 6 e. 4
    c. 5 f. 2

11. a, b, c

12. a, c

13. b, c, d, f